COMBUSTION

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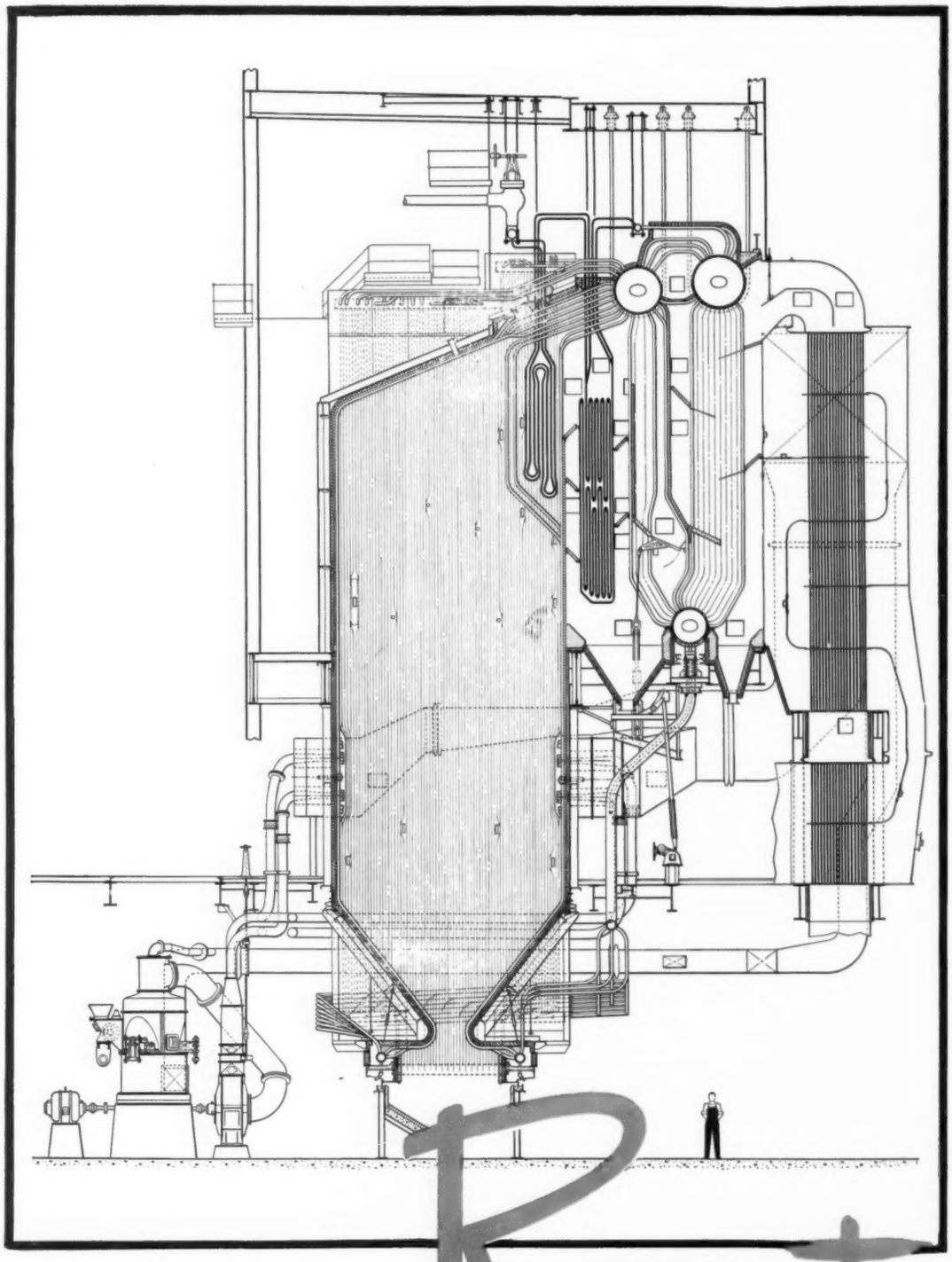
July, 1946

Keystone View Co.

Power Plant Expansion at Paulsboro, N. J. Refinery ▶

A.S.M.E. Semi-Annual Meeting at Detroit ▶

Steam Separation and Purification in Boiler Drums ▶



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COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME EIGHTEEN NUMBER ONE

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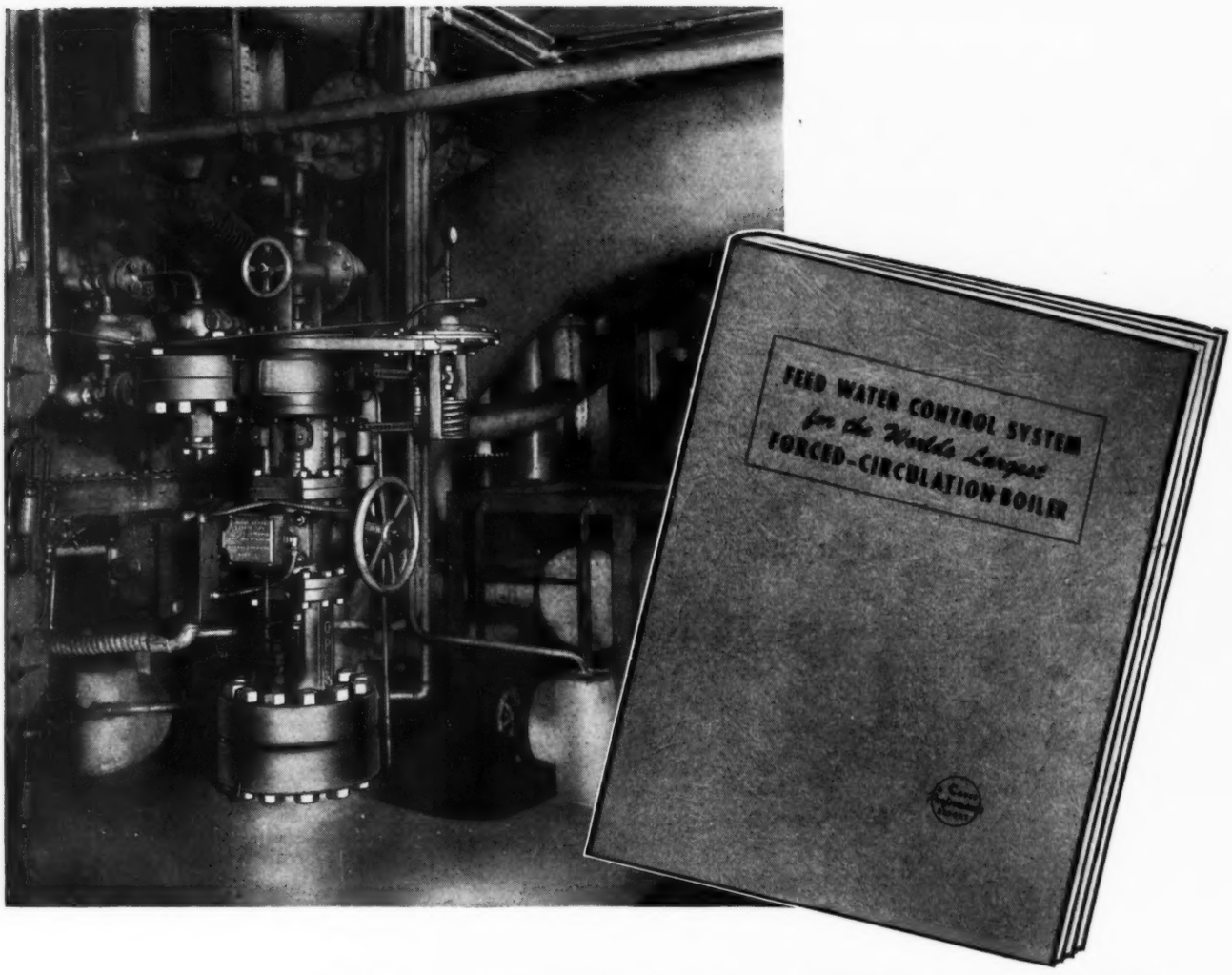

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EDITORIAL

Surplus Property for Educational Use

The vast number of returned veterans electing an engineering education under the G. I. Bill of Rights, plus those entering colleges from high schools, will impose a tremendous burden upon our universities and technical schools next fall. Aside from the acute problems of space accommodations and adequate teaching staffs there will be urgent need for greatly expanded facilities in mechanical equipment for shops and laboratories.

Some such equipment has already been made available by the Army and Navy, but not enough to meet the needs of the various schools. Moreover, much of this has been of specialized character, and the bulk of commercial types of equipment is in the hands of the War Assets Administration as surplus property, at numerous depots throughout the country, where in many cases it is deteriorating for lack of adequate storage facilities to afford the necessary protection.

When Congress enacted the Surplus Property Act of 1944, it recognized the benefits that would accrue by making it possible for educational institutions to procure surplus equipment and supplies at nominal expense because of the very limited budgets of such institutions. It specified that in setting the sale or lease value of such property to educational or health institutions the price should be based on benefits which have accrued to the United States and offer an opportunity for such institutions to fulfill their legitimate needs in the public interest. Interpreting these terms, the War Assets Administration arbitrarily established a figure of 40 per cent discount to educational institutions, but this proved to be far in excess of their ability to pay and very little equipment has passed from the huge government stockpiles to university shops and laboratories. Furthermore, many institutions were barred from the intended benefits by the establishment of minimum quantities to be sold—quantities which are far in excess of the needs in most cases.

However, just recently at the insistence of a committee representing twenty-one leading educational associations, the War Assets Administration has indicated its willingness to modify the price policy to afford a 95 per cent discount on certain categories of material to be used for instruction; but it is understood that this will not apply to items for maintenance and operation.

While this concession goes a long way toward meeting the requests of the educational institutions it has been pointed out that practical training requires much expendable material and that considerable shop and laboratory facilities deteriorated during the war years of intensive use and now require replacements.

Granting the many problems involved in the disposal of surplus government property and the obligations imposed on those charged with its administration, one must not overlook the contribution made by our educational institutions to the war effort, and the task ahead of them in providing training for those whose education was interrupted by the war. Time is short before fall terms begin, and neither inconsequential conditions nor "red tape" should be permitted to stand in the way of putting idle equipment to useful work.

Oil Pipe Lines for Transporting Natural Gas

Disposition by the Government of the "Big Inch" and the "Little Inch" oil pipe lines constructed during the war to transport oil from Texas fields to refineries in the Philadelphia and New York areas is now up for determination, and hearings are being held by the Federal Power Commission. Although these pipe lines performed a vital service during the war, it is generally conceded that they would find it difficult to compete with the cost of peacetime tanker delivery. It has therefore been proposed that they be utilized to bring natural gas to these areas and intermediate points. In fact, at least two companies have been formed with this purpose in view.

As might be expected, opposition has developed from the coal industry, and both the railroads and the United Mine Workers will likely voice objection.

Were natural gas to be brought into this region it is probable that local gas utilities would be the principal customers, where it would be mixed with manufactured gas. It is unlikely that much, if any, would be available directly to individual industrial or residential consumers, although electric utilities might find it a very desirable supplementary or reserve fuel which would be most welcome in the event of interruptions in coal supply such as was experienced because of strikes this spring and may reoccur periodically.

Gas would displace considerable bituminous coal and save much of the oil now used to enrich manufactured gas but its effect on anthracite, which is used mostly by commercial and residential consumers, is not so apparent. Moreover, considering the distances involved, the pumping costs and the present investment in gas-making facilities, it is not likely to have much effect on gas rates to customers, except perhaps where very large quantities are involved.

The hearings before the Federal Power Commission will be followed with interest.

Power Plant Expansion at Paulsboro, N. J. Refinery

Description of the high-pressure extension of power facilities at this refinery of the Socony-Vacuum Oil Company which increases the generating capacity almost fifty per cent. Steam for electric generation and process work is supplied by four 125,000-lb per hr 850-psi, 750-F boilers which are fired by oil, refinery gas, soda tar or acid sludge.

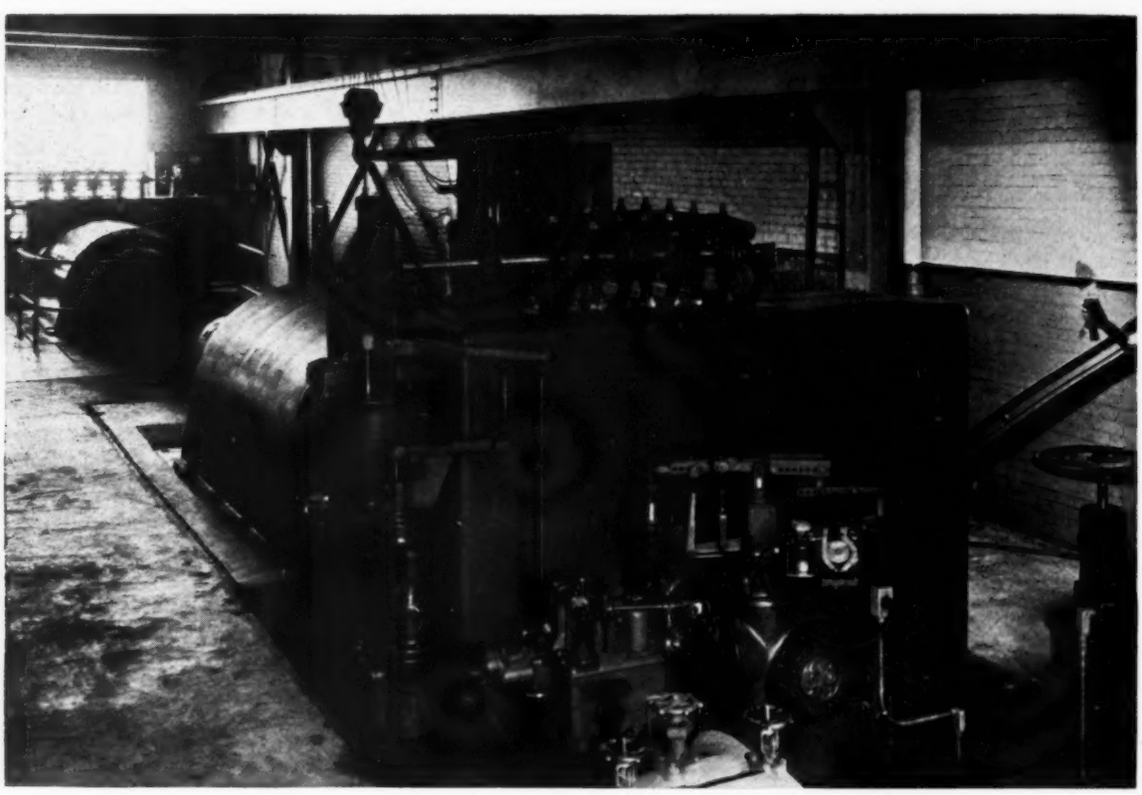
By W. T. SHERMAN
Ch. Power Engr., Paulsboro Refinery, Socony-Vacuum Oil Company

THE Paulsboro, N. J., refinery of the Socony-Vacuum Oil Company, located on the Delaware River about ten miles below Philadelphia, is one of the world's largest lubricating oil refineries. It employs the Houdry and T. C. C. processes of catalytic cracking and the Duosol or Clearosol process for the manufacture of "Mobiloils." As in all such refineries, considerable power and a vast amount of steam are required, but due to contamination of the latter in process equipment the steam returns are small and boiler makeup runs to about 75 per cent.

In order to meet war demands for petroleum products and to provide for anticipated post-war requirements, facilities at the Paulsboro refinery have been progressively expanded over the last several years. This expansion program involved additions to the power plant, beginning with an order for the first of four new 125,000-lb per hr, 900-psi boilers, designed to burn oil, refinery gas, acid sludge and soda tar with future pulverized coal, in July 1943; a second in September of that year; a third in July 1944 and the fourth in August 1945; together with two high-pressure 5000-kw turbine-generators the first of which was ordered in April 1944 and the second in June 1945.

Previous to the present extension, the power plant had a total generating capacity of 11,700 kw with steam for power generation and process work amounting to 850,000 lb per hr. Of this total, 540,000 lb of steam per hr at 415 psig was delivered by three 1732-hp boilers and the remainder at 185 psig was furnished by eleven boilers of various types. Six of the latter, sludge and soda-tar fired, were removed to make room for the four new high-pressure units.

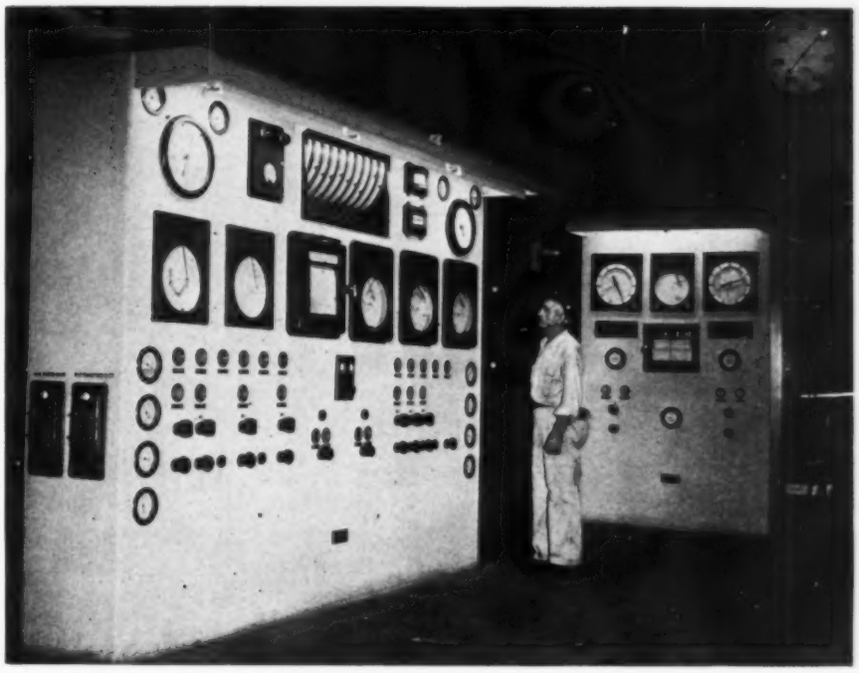
Although the total generating capacity will be 21,700 kw with the installation of the last high-pressure turbine-generator, the normal load will be between 15,000 and



Turbine room of Power House No. 3 showing new 850-psi turbine in foreground

20,000 kw. However, the normal total steam requirements may reach 1,000,000 lb per hr; hence, it is seen that the boiler plant must operate at maximum capacity for long periods. Approximately half of this steam will be supplied by the new high-pressure boilers.

Steam conditions were determined by the feasibility and improved economy of a superimposed layout. Thus the new turbines were designed for steam at the throttle of 850 psig and 750 F total temperature. By employing back-pressure extraction-type turbines, which bleed to the low-pressure turbines, as well as supplying process steam at this pressure coupled with an interconnected system including reducing valve and desuperheating stations, flexibility of operation and continuity of service are insured. The reducing stations comprise two Swartwout 850/415-psi reducing valves and desuperheaters of 300,000 lb per hr capacity each, as well as two Smoot 415/185-psi reducing valves of 120,000 lb per hr capacity each.



One of the high-pressure boiler-control panels, master control panel at right

Retirement of the six old low-pressure boilers provided adequate space within the existing structure of Power House No. 1 for installation of the four new boilers. By utilizing this space advantage is taken of the existing coal-handling facilities including the bunker left intact for use in future pulverized coal operation. Space has been provided for pulverizers, piping and ash-handling equipment. Of considerable advantage and convenience is the location of the operating floor at the burner level thus eliminating the need for platforms for servicing the burners. The boiler control panels and master controls are conveniently arranged for the operators. The deaerating heater is located just outside the building. The water treatment plant is housed in a separate building adjacent to the power house.

The first of the two new high-pressure turbine-generators was installed in an extension of Power House No. 3 which also houses a 5000-kw low-pressure machine. A further addition to this building houses a completely redesigned electrical control station with essential switchboards and offices for the power plant operators. The second turbine-generator will be installed in Power House No. 1.

Makeup water is obtained twice daily from the Delaware River during ebb tide so as to minimize the load of sodium salts on the treating plant. This water is first chlorinated, then stored in a tank of approximately 2,300,000 gallons capacity. Water from the storage tank is coagulated with alum and passed through the gravity filters. From this point, the water to be supplied to the 450-psi boilers receives a sodium zeolite treatment. All condensate returned from the refinery after blending with this treated water is used in the 450-psi boilers.

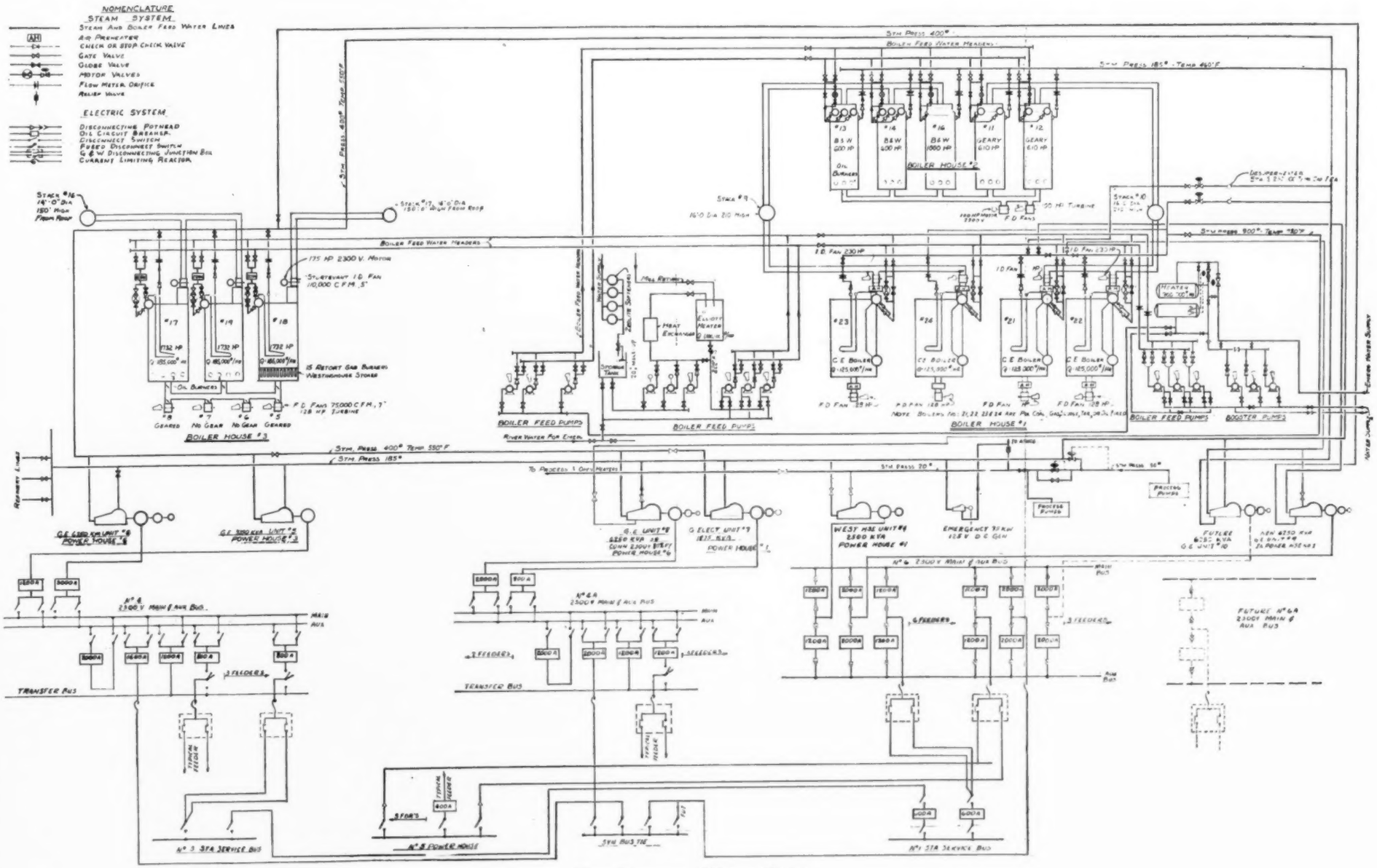
For the high-pressure boilers, the makeup is completely demineralized by means of a Permutit two-stage hydrogen zeolite and deacidizing treatment which results in producing practically distilled water. This treated water is then delivered to a Cochrane deaerating heater having a capacity of 900,000 lb per hr. As a result of this treatment the total solids in the boiler water are maintained at about 500 ppm. Boiler blowdown is continuous and amounts to 5.0 per cent on the 900 psi boilers. Blowdown is controlled to maintain a given salinometer reading which is recorded for each boiler.

Fuels

Of special interest is the use of a variety of fuels. As mentioned earlier, the new boilers are designed to burn pulverized coal in the future operating plan, but for the present are limited to liquid and gaseous fuels. The primary fuel is Bunker C oil, but as in many refineries, there are supplementary fuels which are by-products of the refining processes. These include: refinery gas, from the catalytic cracking and other processes, which has a heating value of 1700 Btu per cu ft; soda tar having a heating value of 18,628 Btu per lb from the tube stills (used in the manufacture of lubricants); and acid sludge with a somewhat lower heating value of 14,341 Btu per lb (due to a high moisture content), which is a residue from the Lubricating Oil Department. These heating values are those upon which the expected performance of the boilers was based and do not necessarily represent the day-to-day values.

The refinery gas is provided by the spillover principle, and, when available, is used at a rate to maintain a process line pressure of 28 psig. At the burner this pressure may vary between 0 and 20 psig. When the burners are incapable of using all the refinery gas being supplied, a flare operating at 35 psig consumes the remainder.

Oil or soda tar may be burned using a steam-atomizing tip in conjunction with gas in the same burner. As the supply of gas varies, the rate of oil flow is regulated automatically so as to give the desired heat input. The supply of acid sludge is fixed, hence, is not used together with gas. The usual practice is to have two burners on oil and two on tar with gas on all four. Fuel oil and soda tar are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Air Preheater
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Gate Valve
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Relief Valve
ELECTRIC SYSTEM
Disconnecting Pothead
Oil Circuit Breaker
Disconnect Switch
Fused Disconnect Switch
G & W Disconnecting Junction Box
Current Limiting Reactor
BOILER HOUSE #3
BOILER HOUSE #2
BOILER HOUSE #1
BOILER FEED PUMPS
BOOSTER PUMPS
POWER HOUSE #1
POWER HOUSE #3
POWER HOUSE #4
TRANSFER BUS
MAIN BUS
AUX BUS
Stack #16 14'-0" Dia 150' High From Roof
Stack #17 16'-0" Dia 150'-0" High From Roof
Stack #9 16'-0" Dia 210' High
Stack #10 14'-0" Dia 210' High
5th Press. 400# Temp. 750°F
5th Press. 185°
5th Press. 400° Temp. 550°F
5th Press. 185°
5th Press. 900°. Temp. 850°F
5th Press. 185° Temp. 460°F
Boiler Feed Water Headers
#13 B & W 600 HP Oil Burners
#14 B & W 400 HP
#16 B & W 1000 HP
#11 Geary 610 HP
#12 Geary 610 HP
#17 1732 HP @ 185,000# Hr
#19 1732 HP @ 185,000# Hr
#18 1732 HP @ 185,000# Hr
175 HP 2300 V. Motor
Stirling Ind. F.D. Fan 110,000 C.F.M. 5"
15 Retort Gas Burners Westinghouse Stoker
Oil Burners
F.D. Fans 75000 C.F.M., 7" 128 HP Turbine
#8 Geared
#7 No Gear
#6 No Gear
#5 Geared
#23 C.E. Boiler @ 125,000#/Hr
#24 C.E. Boiler @ 125,000#/Hr
#21 C.E. Boiler @ 125,000#/Hr
#22 C.E. Boiler @ 125,000#/Hr
F.D. Fan 230 HP
F.D. Fan 128 HP
F.D. Fan 230 HP
F.D. Fan 128 HP
I.D. Fan 230 HP
I.D. Fan 230 HP
Heater 9th "C"
Heater 9th "D"
Heat Exchanger
Elliott Heater
Boiler Feed Water Heaters
Boiler Feed Pumps
River Water For Cond.
To Process & Off Heaters
To Atmos.
Process Pumps
G.E. 3,750 KW Unit #6 Power House #3
G.E. 3,750 KW Unit #5 Power House #3
G.E. Unit #8 6250 KVA 25 Cycle 2300 V Power House #3
G. Electr. Unit #7 1875 KVA Power House #1
West Isl. Unit #4 2500 KVA Power House #1
Emergency 75 KW 125 V. D.C. Gen
Future 6250 KVA G.E. Unit #10
New 6250 KVA G.E. Unit #9 in Power House #3
#4 2300 V Main & Aux Bus
#4A 2300 V Main & Aux Bus
#4 2300 V Main & Aux Bus
Future #4A 2300 Main & Aux Bus
3 Feeders
4 Feeders
Typical Feeder
Spare
Tie
#3 Sta Service Bus
#2 Power House
5th Bus Tie
#1 Sta Service Bus

Flow Diagram of Power Plant

supplied at 125 psig and 250 F; and sludge at 100 psig and 200 to 250 F. Pump and heater sets for the liquid fuels are located outside but adjacent to Power House No. 2. These are able to vary the supply of respective fuels they handle as the situation demands, and especially to compensate for variations in pressure of the refinery gas header. When burning combination fuels, high excess air (25 per cent) is employed to reduce flame travel to insure complete combustion in the furnace.

By proper combustion control good efficiencies are obtained when using any or a combination of these fuels. The following are the expected per cent efficiencies when burning the fuels separately at 125,000 lb per hr maximum continuous rating: oil 84.3, soda tar 84.9 and acid sludge 84.2.

The design of the boilers was based on future operation with pulverized coal having a heating value of 13,600 Btu per lb as fired and an ash fusion temperature of 2500 F.

Although heavy slagging conditions are experienced when using soda tar, they have been solved by installing lancing doors on the convection section of the boiler and changing baffles on the superheater. The alkali used to neutralize the acid in these fuels produces sodium sulphate which, in the furnace, slags and runs down the walls. The carryover in the flue gases is a fine dust, the fused deposits of which can be removed by periodic lancing; soot blowers are used every four hours. The use of a regenerative type air heater with this kind of fuel is unique and experience has proved that it is successful. The heater is kept clean by means of steam soot blowers when inspection through glass observation doors reveals cleaning is necessary. Washing of the preheaters has proved necessary on about a three months' cycle.

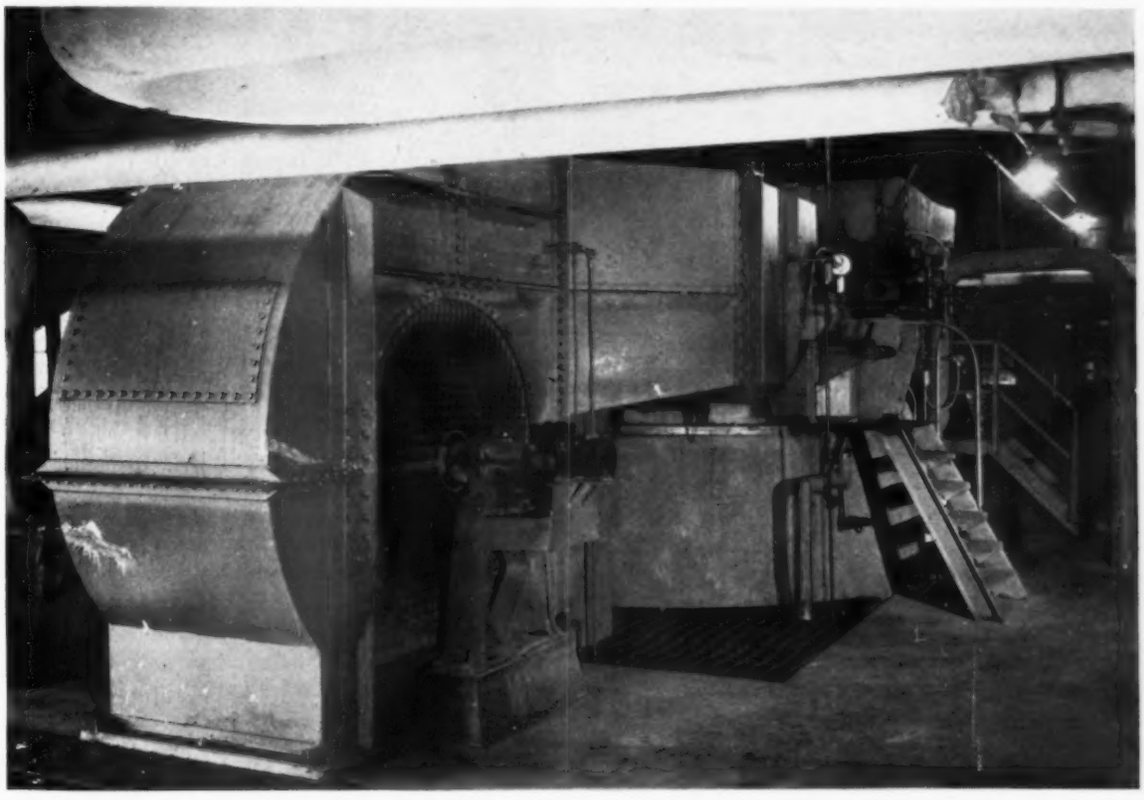
Steam-Generating Units

The four high-pressure steam-generating units are of the Combustion Engineering VU (2-drum) type, having 10,498 sq ft of boiler heating surface.

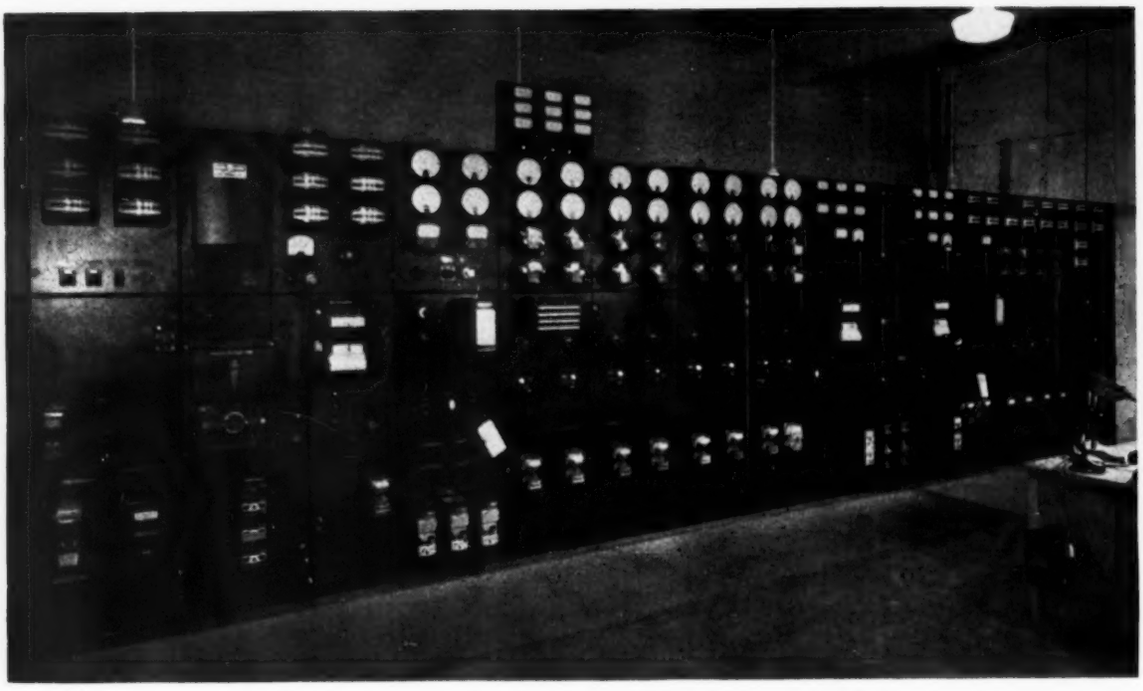
Each delivers 125,000 lb of steam per hour continuously at 850 psig at the superheater outlet and 750 F total temperature with feedwater at 220 F. The furnaces, having a width of 16 ft, 8 in. and a heating surface of 2277 sq ft are constructed of plain 3-in. tubes on the sides, front and roof (with the exception of the last unit which has finned tubes on the sides and roof) and a floor screen to supply the front and sidewall headers. The furnace and boiler walls are completely steel cased. The bottom consists of a brick hopper with access and cleanout doors provided at that level. The furnace bottom is designed to support the front and side walls with beams located under the water-wall headers, so that it will be possible to install an ash hopper with a minimum change in the existing setting when it is desired to go to pulverized coal firing. A furnace volume of 6950 cu ft gives a heat release of 25,800 Btu per cu ft when burning oil.

The superheater is an interbank Elesco type. There is no economizer but a regenerative type Ljungstrom air heater is installed. This has a gas bypass so that the plate temperature may be kept above 270 F to prevent excessive corrosion by sulphur oxides.

Each boiler has four Combustion Type "RO" horizontal burners located in the front wall on two levels which are equipped with Coen type steam-atomizing guns for burning the liquid fuels. The guns for burning fuel oil and soda tar are inside mix, while those for acid sludge, are of the outside mix type. These guns are designed for maximum continuous output of 40,000 lb of steam per



Forced-draft fan in foreground with part of air preheater in rear



View of main switchboard

hour each. All four burners are accessible for quick change-overs and cleaning.

Complete Hagan combustion control equipment is used throughout.

Main Turbine-Generators

The high-pressure turbines are General Electric design of the back-pressure, extraction type with 7 stages and are directly coupled to the generator, exciter and pilot exciter. Steam is admitted at 850 psig and 750 F, extracted at 415 psig and exhausted at 185 psig. The generators are delta-connected, are rated at 5000 kw with 0.8 power factor and deliver at 2300 volts, 60 cycles. A hydraulic restoring mechanism makes the governor isochronous, which gives a constant 3600 rpm to maintain 60 cycles at all loads.

Steam may be drawn from the extraction point of each high-pressure turbine to the extent of 100,000 lb per hr for diversion to the low-pressure turbines or for use in process work while 130,000 lb per hr is exhausted at 185 psig and sent to the process header.

Fans

All fans and air heaters are located on the top floor, the latter installed with the shafts vertical so that the ducts for the heated air and the flue gas from the boiler connect vertically through the floor, thus simplifying the duct work.

Each boiler is served by a forced- and an induced-draft fan of Sturtevant design having separate turbine drives. The forced-draft fan which has a capacity of 60,000 cfm through a single inlet at 10.0 in. wg and 100 F is driven by a 128 hp non-condensing 4000-rpm Westinghouse turbine having a throttle pressure of 400 psig with steam of 100 deg superheat. The induced-draft fan of double-inlet design with a capacity of 99,000 cfm at 10.0 in. wg and 400 F is driven by the same type and make of turbine which operates under the same steam conditions but is a 230 hp machine. These turbines exhaust at 5 psig to the station exhaust header. The speed of the fans is varied by the combustion control system through an orifice-type governor having a 3 to 1 ratio.

Boiler Feed System

The entire feed supply for the four high-pressure boilers is from the deaerating heater. To handle this there are three pumps of Ingersoll-Rand design having seven stages and delivering 750 gpm at 1000 psig and 2660 ft total head. Each pump is driven by 700-hp Westinghouse turbine having a throttle pressure of 400 psig and exhausting at 5 psig. Any two of these pump sets, which are interconnected, will supply all four boilers at maximum rating. Each boiler is equipped with two feed lines, one being an auxiliary.

Boiler-feed pressure is regulated by a Hagan master controller which maintains a fixed differential with the steam header. This control is located on a master panel at the east end of Power House No. 1. Individual boiler-water level is maintained with Bailey 3-element controls.

Electrical Features

There is no outside source for power or lighting but the reliability and continuity of service throughout long years has proved this is not necessary. Power is generated at 2300 volts, 3 phase and 60 cycles and is taken by three 2300-volt buses connected through reactors to a synchronizing bus. Distribution is by an underground 2300-volt radial system, the circuits being ungrounded.

Station auxiliaries in Power Plants 1 and 3 are supplied at 2300, 440 and 220 volts, the former being for motors over 100 hp. Electric power is also supplied to the refinery at 2300 volts. Lower voltages are obtained by means of step-down transformers at the refinery units.

Discussing nuclear energy at dinner meeting. Left to right: President Yarnall, A. L. Baker, Senator McMahon, Past-president Bailey and Rear Admiral Bowen.

A.S.M.E. Semi-Annual Meeting at Detroit

WITH a registration of approximately one thousand, the Semi-Annual Meeting of the American Society of Mechanical Engineers was held in Detroit from June 17 to 20. The technical program covered a wide range of topics including a number of papers on gas turbines, heat transfer, machine design, aviation, process industries, production engineering, research and steam power; only the last will be reported here. In addition to the technical sessions, a number of luncheons and dinners were addressed by speakers on matters of general concern such as engineering leadership, nuclear energy, aviation and military matters.

Speaking at the Monday luncheon on the subject of "The Demand for Leadership," **James W. Parker,** president of The Detroit Edison Company, credited our wartime accomplishments to our peacetime productive facilities, the maintenance of which he believed to be the greatest single factor in insurance against future attack. Moreover, no foreign country has power systems comparable to those in the United States. These accomplishments would have been impossible under government planning and it is vital that engineering science remain free without governmental or international restraints.

Nuclear Energy

Rear Admiral H. G. Bowen, Chief of the Navy's Office of Research and Inventions, pointed out that the U. S. Navy is the largest single user of power in the world and also has the largest single technical organization; hence the development of atomic power for naval vessels offers the very best opportunity to expedite its economical use by industry. He did not predict any miraculous transformation of atomic energy into power, but believed that the heat from fission would be used to produce steam to drive turbines. However, since economy of fuel would no longer be essential, cruising radius would be greatly extended, more advantageous disposal of weights would be possible and higher speeds would be attained by redesigning turbines to increase the output per pound of turbine. It will be necessary to search for an ideal coolant for the atomic pile, that will be fluid from room temperature to 1500 F or 2000 F and not become radioactive to a troublesome extent. Design of the necessary heat exchangers, to replace the conventional boiler, will present a fascinating problem.

Recognizing that uranium and plutonium do not constitute the only atomic fuels, and that thorium may be employed to supplement these elements, the Admiral predicted that tremendous energy release would be found to accompany the fusion of certain light elements, possibly as cheap and plentiful an element as hydrogen.

A. L. Baker, General Manager of The Kellex Corporation, stated that the Manhattan District has now announced the Daniels pile as available for peacetime use, and that development will proceed regardless of certain barriers. Compared with present fuels, the gain factor

will be in the neighborhood of four million to one. The controlled use of nuclear energy, he said, is now an accomplished fact and, although fission does not require high temperatures, they are essential to high efficiency which may require new materials. He believed the most obvious initial application of atomic power to be ship propulsion and central stations. Remote control will be essential and specially trained personnel will be required, but the feedwater problem will still be with us. Also, entirely new safety codes will become necessary and there is the possibility of theory being reduced to practice before adequate codes are established.

The third speaker at the dinner was **Senator Brien McMahon,** Chairman of the Joint Congressional Committee on Atomic Energy and author of the McMahon Bill for the control of nuclear energy. The intent of this bill, he explained, is not to restrict or retard development or utilization of nuclear energy, but to do it in an orderly and evolutionary manner. Provision is made for an Atomic Energy Commission of five civilian administrators to direct military applications, research, production and engineering. An exclusive government monopoly of facilities for the production of fissionable material would be set up; private ownership is expressly forbidden, except for small amounts of the material incident to research, but provision is made for the operation of such facilities under management contract when such is deemed desirable. Patents could be issued for all types of inventions except those related to the production of fissionable materials for military use. In such cases the Commission may make compensation to the inventor in lieu of a patent. Furthermore, the manufacture of equipment for utilizing fissionable material would be subject to licensing by the Commission, but no such license would be issued until Congress has had a period of 90 days to consider a report on the social, political, economic and international effects of the use of the device.

Acid Cleaning of Boilers

"Acid Cleaning of Boilers and Auxiliary Equipment" was the subject of a paper by S. T. Powell, consulting chemical engineer of Baltimore, Md. Although the use of acid to remove deposits from metallic surfaces has been practiced for many years and in widely divergent industries, its use in removing encrustations from boilers has not been generally employed until recent years. It was the extensive acidizing of oil wells to improve yields by removing deposits and opening the formations that attracted interest and suggested other applications.

During the last 4 or 5 years, because of the need for reducing boiler outages and because of the shortage of labor, acid cleaning has made the greatest strides. In this period thousands of boilers and auxiliary equipment such as deaerators, condensers, heat exchangers and the like have been acid cleaned.

To protect the metal surfaces against attack and subsequent corrosion by the acid the use of inhibitors is employed.

As to the practical effect of acid cleaning on boiler steel, studies of metal that has been repeatedly acid-cleaned show that some corrosion occurs each time but at a rate which is low enough so that even after many cleaning cycles no serious concern is felt. A careful inspection of the internal metal surfaces especially the highly stressed areas is advisable to evaluate the rate of attack. It is a well-known fact that this rate of attack by acid or any other electrolyte is greatly affected by the internal stresses in the material. It was shown that the flared tube ends, highly stressed during the cold working of rolling, are readily attacked by inhibited acid even when the unstressed metal has shown no corrosion.

To insure effective removal of encrustations from the surfaces and a minimum of corrosive attack on the metal, numerous conditions require control during acidizing. The more important of these conditions include:

1. Composition and concentration of the acid.
2. Nature and composition of the inhibitor.
3. Temperature of the metal and of the solutions.
4. Circulation.
5. Composition of the metal.
6. Physical and chemical composition of the scale.

The use of muriatic, sulphuric or other common mineral acids will not always remove certain encrustations such as the silicate and sulphate scales.

To insure the removal of these compounds, hydrofluoric acid or other sources of the fluoride ion must be used. The strength of the acid must be governed by the time available for cleaning. Concentrations of 4 to 7 per cent are in order with a maximum of 15 per cent.

It is particularly important that the temperature of the solution and the metal surfaces be maintained between 140 and 160 F to prevent excessive corrosion. Higher temperatures in isolated areas may prove detrimental.

It can be expected that greater corrosion will occur on the surfaces of lower-grade and inferior steels.

Emphasis was put on the importance of employing only the most experienced persons to perform acid cleaning to avoid the dangers of corrosion and the hazards inherent in the operation. The latter include the danger due to improper venting to purge the boiler of hydrogen gas. Proper procedure should also be taken to thoroughly remove the acid after cleaning.

Discussion

In discussing this paper, **L. E. Hankinson,** of West Penn Power Company, emphasized that acid cleaning should be undertaken only by trained and experienced personnel. He also stated that acid cleaning could usually be avoided by proper water conditioning, which is more economical and the loss of heat transfer due to fouled surfaces is reduced. Furthermore, acid cleaning removes the protective oxides.

Guy F. Williams, of Dowell, Inc., stated that the metal loss from acid cleaning was actually less than that resulting from mechanical cleaning. He stated that the frequency of acid cleaning can be determined after the rate of scale formation is known.

M. H. Kuhner, of the Riley Stoker Company, pointed out that the highly stressed flared tube ends which are subject to such high corrosion and which really serve no purpose should be eliminated.

A written discussion by **Dr. R. E. Hall** showed how ferric ion that is in the spent cleaning solution can dissolve steel and that concentration in local areas

can result in serious pitting. Under certain conditions, he said, alkaline cleaning should be employed rather than acid cleaning.

Automatic Air Soot Blowers

The first paper in the Power Session on Tuesday morning, which was presented by **H. L. Smith** of the Buffalo Niagara Electric Corporation, dealt with the automatically controlled soot blowers using compressed air in place of steam at the Oswego and Chas. R. Huntley steam stations. The installation described is employed on three boilers of 900,000 lb per hr capacity, 1320 psig and 900 F, two at Oswego and one at Huntley.

Selection of air for soot blowing was based on the findings of a study to determine the economic factors involved. These included reduction to a minimum of the steam lost from the closed system, reduced capacity in water-treating equipment and improved quality of feedwater. It was estimated that the steam output normally used for soot blowing would be reduced from $1^1/_2$ per cent to less than $^1/_2$ of 1 per cent. It was also considered that in those stations where additional steam capacity required for steam soot blowing was considered unnecessary, the overall investment based on the use of air was lower. In this connection selection of lower steaming capacity made possible by the use of air may not always be a consideration, but there will be a marked saving on the cost of water-treating equipment. In the case of units converted to an air soot blowing system the resultant saving will be shown in reduced operating costs.

The blower elements and automatic controls were furnished by Diamond Power Specialty Company. Retractable wall blowers are employed in the furnace while telescopic and permanently located elements are to be found throughout the rest of the unit, including the economizer. The elements are arranged in groups for the purpose of economizing in the capacity of the air-compressing equipment and to facilitate the use of automatic control. Economy is effected by taking advantage of the maximum time allowed for one complete boiler-cleaning cycle and operating the compressor continuously. The elements within a group operate one at a time and between groups there is a time delay during which the air supply is restored to enable blowing the next group at full pressure (250 psi).

The controls for each group are operated in turn from the main program panel consisting of a group of selector switches. By proper setting of these switches groups may be blown automatically in any order desired.

Five years of operation with automatic air soot blowers indicate favorable results, namely:

1. Unusual cleanliness using none other than the soot blowers.
2. Air requirements, fluctuation in storage-tank pressure and total operating time are less than anticipated. Complete blowing requires about 5 hr.
3. Energy consumption for compressed air is the only daily operating cost of any consequence. Each boiler with a daily output of 15,000,000 lb of steam (65 per cent load factor) requires 3400 kwhr to compress air for soot blowing. This is equivalent to 227 kwhr per million pounds of steam.
4. Maintenance costs have been low.
5. Erosion of boiler pressure parts due to injury by air blowing has been slight.
6. Other advantages of significant value are:

(*a*) Makeup has averaged 0.3 per cent compared to 1.5 per cent as anticipated for steam blowing which means reduction of 80 per cent in the amount of total solids entering the steam system.

(*b*) Ability to operate the boilers continuously on automatic control.

(*c*) Removal of the human element in operation of the blowers.

As to operating costs the difference in daily fuel consumption is 5.7 tons of coal per day in favor of compressed air.

Many other boilers in addition to these are equipped with automatic air soot blowers including the 400,000 lb per hr unit of the Long Island Lighting Company, Glenwood Landing Plant.

Burning Low-Grade Midwestern Coals on Continuous-Discharge Spreader Stoker

John M. Drabelle, of the Central States Electric Company, reported upon his recent installation at Iowa Falls, Ia. in which a 125,000-lb per hr two-drum Combustion Engineering boiler is fired by a six-feeder Detroit spreader stoker of the continuous-discharge type 20 ft 3 in. wide by 15 ft 8 in. centerline to centerline of shafts. Incorporated in the unit is a superheater, a tubular air preheated, a cinder-return system, overfire air jets and combustion control. The steam conditions are 420 psig and 750 F total steam temperature. Coals from the Northern Illinois and Iowa fields are burned. Operating results were given as well as a review of the conditions of furnace, boilers, superheater, air preheater, precipitator, fans and stoker after 6000 hr operation.

In choosing between pulverized coal and stoker firing for this unit consideration was given to the grindability index of the available coals, which would have required relatively large power for pulverizing. Two mills, each driven by a 125-hp motor, would have been necessary, compared with 30 hp for the stoker drive, including the over-fire air fan and cinder return. This savings in "parasite" power was balanced against the slightly higher efficiency attainable with pulverized coal.

Since successful spreader-stoker firing depends upon sizing of the coal, a crusher is employed to reduce the coal as received to $^3/_4$ in. and under. Also, in order to prevent the deposit of fly ash from forming into slag and choking gas passages and the superheater, alternate tubes of the back wall section of the furnace are bent forward to provide liberal gas passages. The furnace is completely water-cooled except for a small amount of refractory around the spreader units on the front wall. Calculated heat absorption at full rating is 52.1 per cent in the furnace, 31.4 per cent by the boiler and 16.5 per cent by the superheater.

All fly ash collected in the various passes and in the dust collector is returned and reinjected into the furnace. The multi-cyclone dust collector, of Western Precipitation type, is installed ahead of the induced-draft fan. Analysis of samples of the fly ash collected at the boiler passes and in the multi-cyclone showed 19.58 per cent combustible after the first pass (super-

heater section), 10.36 per cent after the second pass (convection section), and 17.96 in the multi-cyclone. Combustible in the stoker ash ranged from 1.92 to 3 per cent. No cinder nuisance has been noted around the plant and the stack has been clear at all times.

The unit was in continuous and uninterrupted operation from July 20, 1945, to March 31, 1946, when it was shut down for inspection. According to Mr. Drabelle, no serious difficulties have been encountered in the operation of the stoker, boiler or furnace after adjustment had been made of the grate speeds and the coal feeders to conform to and be a part of the Bailey combustion control system. Such operating difficulties as were encountered were minor and concerned the auxiliaries.

Fuel burned during this period ranged from poor strip-mined coal of 9296 Btu, 9.47 per cent ash and 8.12 per cent moisture, to fair strip-mined coal of 11,410 Btu, 7.58 per cent ash, 12.56 per cent moisture, and to good shaft-mined Northern Illinois coal of 12,065 Btu, 8.51 per cent ash and 6.72 per cent moisture (air dry). The average ash-softening temperature was 1950 F.

No Code test has been run on the combined unit, but from a test of 8 hr duration, employing station instruments, an indicated efficiency of 84.97 per cent was obtained at an evaporation rate of 88,000 lb per hr. The cost per thousand pounds of water evaporated, exclusive of maintenance and fixed charges but including labor, water, fuel and feedwater treatment averaged around 30 cents.

The inspection period from March 31 to April 10, after 6072 hr of uninterrupted operation, revealed no slag deposits on the water walls, roof tubes or at the gas inlet to the superheater pass, and no slag or fly-ash deposits on the superheater. The convection section of the boiler was clean, no tube cutting from soot blowing was apparent, and there was no evidence of erosion or corrosion in the tubular air preheater. The precipitator was found to be in excellent condition and there was no observable wear on the induced-draft fan wheel or the gunite case lining. No wear was noted on the stoker mechanism, although the chain drive on one section was tightened 1 in. The water surfaces of the boiler, water-wall headers and tubes were examined and found to be free from deposits. The inside of the drum and tubes had a very thin dark reddish-brown layer through which the original surface could be clearly discerned. However, the chemical feed line carrying phosphate into the drum was found nearly plugged with a dark, nearly black, material, probably carbonized tannin from the phosphate mixture. The unit was returned to commercial service on April 10.

Discussion

The paper evoked considerable discussion both written (which was not read) and oral.

H. C. Carroll called attention to the fact that the load factor on this unit was only 53.8 per cent which would indicate that it was not on base load. He pointed out that a stoker of this type will burn successfully a high percentage of coke breeze (over 50 per cent) mixed with low grade coal.

J. A. Keeth, of Kansas City Power & Light Company, considered the coal used as fairly good compared with much that is available in the Kansas City area, and pointed out that the stoker had not been charged with the power required to drive the crusher. He questioned whether such equipment would be desirable if long banking periods were involved.

H. A. Kleinman, of the Iowa-Illinois Gas & Electric Company, stated that deposits from spreader stokers in air preheaters do not follow the same temperature relations as in the case of pulverized coal. He listed as prerequisite to good results with spreader-stoker firing a good dust collector system and the best type of combustion control attainable.

C. T. Stripe, of Combustion Engineering Company, stated that permissible throws with spreader stokers, based on model researches, were 24 to 25 ft and that his company is now building such stokers of the continuous-discharge type with throws up to 20 ft. This is considerably in excess of that employed by the unit under discussion which is under 15 ft, and permits greater capacity without increasing the furnace width.

R. L. Beers, of Detroit Stoker Company, pointed out that with this type of stoker it doesn't make much difference as to the ash characteristics, as the depth of ash bed is flexible and that it is not confined to burning midwest coals. Maintenance is apt to be higher with the dumping type of grate as it is unprotected during cleaning periods. He saw little advantage in sizing as the stoker can throw as much coal to the front or rear as desired.

In closing **Mr. Drabelle** stated that the load factor was governed by the load on the turbine and the heating steam demand and that no rapidly fluctuating load is encountered. The coal crusher required a 15-hp motor, and the grate speed is maintained constant. The fuel burned was dictated by what was available, which happened in this case to be about 55 per cent of the better grade.

Boiler for Extreme Load Variations

A single boiler and turbine-generator installation at the Harbor Steam Plant of the City of Los Angeles was designed as a standby to the hydroelectric system and to be able to pick up load of 50,000 to 60,000 kw automatically within seconds in the event of interruption of the hydro power. The steam-generating unit at this plant, which embodies large water-storage capacity, was described in a paper by **M. H. Kuhner,** chief mechanical engineer of Riley Stoker Corporation.

In such an installation when the steam-output rate of the boiler increases as much as eleven-fold in 4 or 5 seconds the firing rate, despite oil fuel, cannot be expected to increase proportionately; nor can the fans under automatic control pick up without some lag. During this interval the boiler must act as a steam accumulator, flashing steam under reduced pressure to meet the demands of the turbine. The water capacity of this three-drum unit (plus dry drum) is 3500 cu ft, compared with 2500 cu ft for a standard boiler of similar rating of 650,000 lb per hr at 1000 psig, 900 F. When operating under standby conditions its hourly steaming rate is between 60,000 and 100,000 lb per hr at 1040 psig drum pressure, but during accumulator operation a pressure drop of 100 psi is permissible before capacity power output of the plant becomes impaired. The 22-second time lag is usually enough for the fuel-burning

rate to increase sufficiently to meet the new steam-output demand.

Rapid steam-load changes are accompanied by water-level variations, hence it is important that the steam-release drum be unusually large. In this case it is 66 in. ID. The normal water level in this drum is 9 in. below the center line and the level may rise 11 in. from normal with a sudden load reduction. All steaming tubes enter the drum above the normal water level and a 36-in. dry drum is located 14 ft above the steam-release drum. The main drum contains a steam scrubber and the upper drum has a dryer.

Discussion

In discussing the paper, **Prof. A. G. Christie,** who had acted as consultant in the design of this steam plant, cited an interruption in the hydro power from Boulder Dam, last March, when an airplane collided with the transmission line and cut off 360,000 kw. The surge dislocated the system and cut out some of the other contributing supply stations. At the time the Harbor Plant was without its house turbine, which had previously been shipped to Russia, and in its absence the low frequency caused some of the auxiliaries to kick out. However, the operators dropped the load and built up the frequency to permit the contributing stations to come on the system. While this failure to pick up was due to the absence of the house turbine, other cases were cited where the installation performed as anticipated. Replacement of the house turbine was made last April.

Mr. Kuhner also described another quick pickup installation at the Homestead Works of the Carnegie-Illinois Steel Corporation. This unit of 450,000 lb per hr capacity is fired by blast-furnace gas as the main fuel with pulverized coal to make up any deficiency. Sudden changes in steam demand at the rate of 250,000 lb per hr take place and, because the supply of blast-furnace gas cannot be changed as rapidly as necessary to parallel steam demands, the load swings are handled by pulverized coal.

Fuels Sessions

At the second Fuels Session **Thomas C. Cheasley** reported on accomplishments of The Nation Fuel Efficiency Program; **Howard A. Herder** told of German practice in the industrial use of coal as he observed it on a recent tour of the American, British and French zones of occupation; and **O. L. Scales,** of the Enos Coal Mining Company, dealt with the importance of size consist control in burning bituminous coal, illustrating this with excellent colored motion pictures taken of furnace conditions over a chain-grate stoker.

Mr. Cheasley reviewed the organization that was set up for handling the program in some 200 of the principal cities. This consisted of a council made up of well-known fuel utilization experts, a coordinator in each of the districts and over 4000 volunteers who made local surveys and offered assistance to plants in effecting fuel economies. Along with this over a million copies of 52 helpful "quiz sheets" were distributed showing how to prevent waste and these were supplemented by posters. In all, nearly sixteen thousand plants were contacted and cooperation pledged. Utility plants were not included inasmuch as it was assumed that they had sufficient engineering talent to effect all possible savings.

While complete data are lacking as to the exact amount of coal that was saved, reports received indicated definite savings of over five million tons during the year, with the possibility, gained from random reports, that total savings may have nearly doubled this figure.

Reporting on "The Industrial Use of Coal in Germany"[1] **Mr. Herder** cited prewar figures on the production of bituminous coal, brown coal and anthracite and outlined the mining methods employed. With regard to coal-burning plants and their equipment, he had observed many mine-mouth plants serving extensive and interconnected transmission systems. In this way it was more economical to burn the low-grade brown coal at the mines than to transport it to other sites. Pulverized coal was burned quite generally in the large stations, and both chain-grate and overfeed-inclined-grate stokers in many industrial plants. There were very few underfeed stokers. Many high-pressure forced-circulation boilers were observed. No information whatever was available as to practice in the Russian zone of occupation.

Mr. Scales explained, by means of slides, how the coal at his company's mines is sized and then blended as desired to provide the desired proportions of each size in the total mix. His motion pictures showed the poor furnace conditions resulting from improperly sized coal and compared these with others showing excellent fires when the coal had the proper size consist. They also demonstrated the beneficial effects of overfire air.

Terminal Velocity for Measuring Dust

In a paper on "Terminal Velocity as the Measure of Dust Particle Characteristics" **R. B. Foley,** of American Blower Corporation, stressed the importance of considering the size, shape and density of dust particles in determining their behavior. The common practice of considering particle diameter, measured in microns, deals with size only and thus neglects the other two important factors of shape and weight. Moreover, most industrial dusts, including fly ash, are a mixture of particles of irregular shapes and various densities. However, the combined effect of these three characteristics is reflected in the *terminal velocity* which is defined as the ultimate velocity the particle will attain in falling through a given quiescent fluid. That is, it is the velocity at which the resistance of the fluid to the motion of the particle equals the gravitational force on it, so that an equilibrium of forces is established, acceleration ceases, and the velocity becomes constant.

Two much-used methods of analyzing dusts and granular materials depend upon their aerodynamic characteristics. These are the sedimentation method and the elutriation method, each of which involves determination of the terminal velocities. With the former the terminal velocity, or rate of fall, is measured in a quiescent fluid, generally a liquid; and the analysis is usually made by determining the percentage of weight of the sample which falls through a given distance in definite time intervals. The elutriation method is the

[1] A fuller abstract of Mr. Herder's paper will appear later.

reverse of sedimentation, and analysis is made by carrying upward in a fluid stream those particles which have a terminal velocity less than the upward velocity of the fluid. Air or water are the fluids most used.

Mr. Foley cited a common practice of expressing the results of analyses, by the sedimentation or the elutriation methods in terms of particle diameter in microns. The transition from terminal velocity to particle size is based on Stokes Law, by means of the following equation:

$$Vm = \frac{a_v}{K} g d^2 \left(\frac{\rho - \rho_0}{\mu} \right)$$

where

V_m = terminal velocity
a_v = a constant depending on particle shape
d = diameter of the particle
ρ = density of the particle
ρ_0 = density of the fluid medium
g = acceleration due to gravity
μ = viscosity of fluid medium
K = a constant varying with particle shape and is 3π for spheres.

When calculating the particle diameters corresponding to various terminal velocities, it is necessary to assume that all the particles are spheres and of uniform density in which case the equation for particle diameter, in microns, becomes

$$d = \sqrt{\frac{18\mu Vm \times 10^8}{g(\rho - \rho_0)}}$$

The author believed that use of this transition is most unfortunate, since in most cases incorrect assumptions must be made; for few dusts are spherical and many are heterogeneous mixtures of materials of different specific gravities.

Air velocities employed in pulverizers, in handling primary air and coal in pipes, in the classifiers and separators and even the fuel distribution to the burner nozzles, are all dependent upon the terminal velocities of the fuel particles. After the coal is burned there are still the problems of fly-ash elimination and disposal which involve the handling of fine particles and with these, also, a knowledge of the terminal velocity is important.

The author suggested "inches per minute" as the logical unit of measurement to express terminal velocity, and believed that this should be standardized in order to provide engineers with data in useful form.

Smoke Abatement Panel Discussion

With **J. F. Barkley** of the U. S. Bureau of Mines presiding, this panel was made up of **Thomas C. Cheasley** of Sinclair Coal Company, **E. B. Brundage,** Smoke Abatement Engineer of the City of Rochester, **W. A. Carter** of the Detroit Edison Company, **F. A. Chambers,** Deputy Smoke Inspector, City of Chicago, **F. J. Gibbons,** Acting Chief Smoke Inspector of Detroit, **H. B. Hebley,** Director of Research, Pittsburgh Coal Company, and **W. E. E. Koepler** of the Pocahontas Operators Association.

Responding to the question of the relation between business activity and atmospheric pollution, **Mr. Hebley** showed slides plotted from observations taken in the Pittsburgh area covering weather and visibility over the past 15 yr and compared these with the industrial indexes. This comparison indicated clearly that activity of the heavy industries directly affected visibility. The sunshine records in Pittsburgh were highest during the depression years.

The second question was: Under what conditions should Nos. 2, 3, 4 and 5 smoke be permitted? Opinions on this question varied. **Mr. Brundage** considered the emission of No. 2 smoke for 8 min in a 30-min period as unobjectionable. **Mr. Chambers** stated that Chicago does not prohibit No. 2 smoke, except where it may be a nuisance, and until recently prohibited No. 3, or blacker smoke, except for 6 min in 24 hr to permit fires to be cleaned or new fires built.

Mr. Gibbons, speaking of Detroit, believed that a plant in good order would have no difficulty in complying with that ordinance which allows dense smoke for 2 min three times an hour. He was of the opinion, however, that perhaps as much of 75 per cent of the plants in that city are antequated and also that they cannot get the kind of coal desired. He stated that adequate furnace volume and turbulence would eliminate much of the present smoke. **Mr. Carter** also stated that it had not been difficult to meet the Detroit requirements until recently when only poorer coal could be had. He showed slides of model experiments to illustrate the effect of stack height on dispersion of gases and dust. **Mr. Cheasley** stated that more than a thousand locomotives have been equipped with overfire air jets to cut down smoke, but the human factor in their use is still a problem.

Nominations

The nominating committee reported the following slate of officers of the Society to be voted upon by letter ballot in the fall and assume office at the conclusion of the Annual Meeting in December. These included a president, five regional vice presidents, and four directors-at-large.

President: **Eugene W. O'Brien,** vice president of the W. R. C. Smith Publishing Co., Atlanta, Ga.

Vice-Presidents: **Alton C. Chick,** assistant vice president of the Manufacturer's Mutual Fire Insurance Company, Providence R. I.—renominated for Region 1 to serve one year

A. R. Mumford, development engineer with Combustion Engineering Company, New York—for Region 2 to serve two years

E. E. Williams, general superintendent of steam plants, Duke Power Company, Charlotte, N. C.—renominated for Region 4 to serve two years

T. S. McEwan, vice president of McClure, Hadden & Ortman, Chicago—renominated for Region 6 to serve two years

Linn Helander, head of mechanical engineering department, Kansas State College, Manhattan, Kans.—renominated for Region 8 to serve two years

Directors-at-Large: **F. S. Blackall, Jr.,** president of Taft-Pierce Manufacturing Company, Woonsocket, R. I.—to serve four years

B. V. E. Nordberg, executive engineer, Nordberg Manufacturing Company, Milwaukee, Wis.—to serve four years

L. F. Moody, professor of hydraulic engineering, Princeton University—to serve two years

W. A. Carter, technical engineer of power plants, Detroit Edison Company—to serve two years.

Coal Utilization in Canada

This abstract of the recently released report of a survey made by the Fairmont Coal Bureau for the Canadian Royal Commission on Coal shows the extent to which fuel in industrial establishments is hand fired, burned on stokers of different types and in pulverized form. Coal consumption figures are also given.

DURING the twelve months ending March 31, 1945, Canada consumed slightly more than 41 million tons of bituminous coal and over 4 million tons of anthracite. Of the bituminous coal burned approximately 17 million tons were produced in Canada and 24 million tons imported from the United States.

Although the survey did not include every industrial power plant, it covered 7296 bituminous coal-burning boilers, which were believed to be representative of Canadian practice. In addition, there were 325 oil-burning units and 1193 small anthracite-burning units. The total represented over 4000 individual plants.

The following tabulation shows the methods of firing the 7296 bituminous coal-fired boilers surveyed, their average horsepower and the per cent of total coal burned.

Firing Equipment	*Units*	*Avg Hp per Unit*	*Per cent of Total Coal Burned*
Hand-fired grates	2849	82.4	9.1
Underfeed stokers	3486	126.1	35.0
Traveling grates (including chain grates)	506	399.7	12.3
Spreader stokers	202	325.8	5.5
Pulverizers	170	911.0	36.9
Overfeed stokers	83	199.7	1.2

Of the underfeed stokers 226 are of the multiple-retort type.

The coal tonnage mechanically fired may be subdivided as follows:

Pulverizers	40.6 per cent
Underfeed stokers	38.5 " "
Traveling grates	13.6 " "
Spreader stokers	5.87 " "
Overfeed stokers	1.43 " "

The relatively small number of pulverized-coal-fired units reported (170) burn the largest tonnage of coal (36.9 per cent), inasmuch as they represent much larger units than do other types of firing. Underfeed stokers account for the next largest tonnage although the average unit size is relatively small.

A trend toward more extensive use of spreader stokers is shown by the fact that in 1944–1945 there were installed 112 such units compared with 38 of the traveling grate and multiple-retort types in the same period. Moreover, the trend is also toward installation of larger spreader stokers.

With reference to distribution among the several provinces in Canada, the survey showed that in Quebec over 54 per cent of the bituminous coal consumed by industrial plants is burned on underfeed stokers and in pulverized form; whereas only 12.4 per cent is hand fired. However, there are over 1000 hand-fired small anthracite blower installations in the province.

In Nova Scotia 62 per cent of all industrial bituminous coal for steam raising is burned in pulverized form, but underfeed and traveling-grate stoker-fired units account for 46 per cent of the total installed horsepower. Considerable anthracite and coke breeze are used in mixture with bituminous coal on traveling-grate stokers in this area.

In New Brunswick pulverizers account for 64 per cent of the mechanically fired bituminous coal; underfeed stokers for 31 per cent, and traveling or chain grates and spreaders for the remaining 5 per cent. Hand firing uses only about 1.5 per cent of the total bituminous coal consumed in this province.

Underfeed stokers use slightly over 60 per cent of the industrial bituminous coal in plants reported for Prince Edward Island.

Ontario is the largest coal-consuming province and underfeed stokers and pulverized-coal-fired units use nearly 80 per cent of the bituminous coal consumed in industrial plants.

In Alberta traveling or chain grates predominate and constitute 74 per cent of the total. They consume 81 per cent of all the coal burned mechanically. Only four pulverized-coal units were reported in this province, although they consume more than 10 per cent of the mechanically fired coal.

In Manitoba underfeed stokers represent nearly 51 per cent of the number of units mechanically fired, with spreader stokers constituting the next largest group in point of numbers. Pulverized-coal-fired units, while fewer, exceed the spreaders in the amount of coal burned. Chain-grate stokers rank third in number but use only 9.5 per cent of the coal.

Pulverized-coal-fired units in Saskatchewan are of much greater capacity, averaging 1438 hp; and, while they represent only 7.5 per cent of the total number, they consume 52 per cent of the coal mechanically fired. They include utility plant units. In this province hand-fired units constitute 26 per cent of the total, but use only 19 per cent of the coal. However, they are of somewhat larger individual capacity than those found in the eastern and maritime provinces.

In British Columbia chain-grate stokers constitute the largest number of mechanically fired units and consume about 25 per cent of the coal. Here the preponderance of the coal is sub-bituminous and lignite.

Commenting upon the results of the survey, the report points out that the older steam-generating equipment in Canada, generally, is restricted to the burning of certain types and sizes of coal. Because of the fact that there is such a variety of bituminous coals available, and due to the marked improvement in equipment design, the present trend is toward installation of more flexible equipment with respect to fuels. Inasmuch as ash-fusion temperature is probably the most critical factor in the design of boiler units, and because the ash-fusion temperature of coals used in Canada varies from 1900 to 3000 F, plants in most of the geographical sections should be designed to accommodate a wide range in ash-fusion temperature.

Photo shows trap draining boiler superheater header.

One of a series of advertisements, each discussing trapping practice on a different class of equipment.

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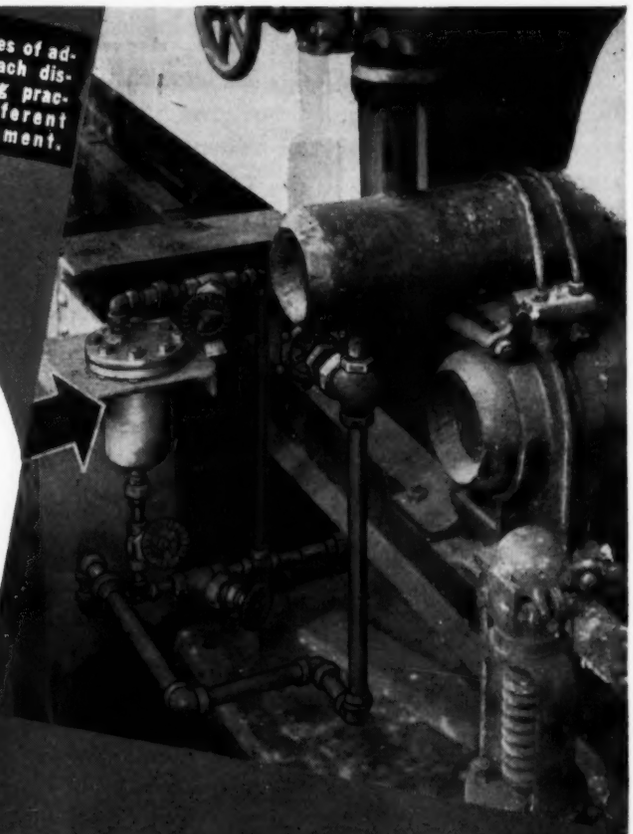

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Steam Separation and Purification in Boiler Drums

By P. B. PLACE

Combustion Engineering Company

An explanation of the steps necessary to accomplish moisture separation and purification of the steam, together with charts on efficiency of separation and a discussion of the control of foaming which is responsible for many of the carryover problems.

STEAM generated in a boiler is delivered to the upper drums mixed with circulating water, foam and sludge. From this mixture practically all of the water and dirt must be separated in order to obtain steam of satisfactory quality and purity. Excessive amounts of moisture left in the steam may cause corrosion in a superheater, loss of superheat, water hammer in steam lines, leakage in flanged joints, or damage in a turbine. The solids associated with only small amounts of moisture left in the steam may result in salt deposits in the superheater, turbine, valves and traps, and loss of turbine capacity.

The amount of moisture left in steam, after separation and purification, is defined by its *quality*, in per cent moisture, and the amount of solid impurity is defined by its *purity*. Some years ago, a steam quality of $^1/_2$ per cent moisture was considered satisfactory. Present standards call for a steam purity of less than 1 ppm contamination. A $^1/_2$ per cent moisture steam, generated from a boiler water of 2000 ppm concentration, represents a solid impurity of 10 ppm in the steam; and 1 ppm impurity in steam generated under the same conditions, represents a moisture content of only 0.05 per cent. The progress in steam purification is evident in these values.

This process of separation and purification is accomplished within the boiler drums by the aid of baffles and other devices collectively known as drum internals. Separation and purification is a sequence of two or more steps and the drum internals consist of devices, integrated to perform the process in proper sequence. The principal steps involved are:

1. Primary separation.
2. Steam washing.
3. Steam drying.

These steps may be compared with the process of washing clothes. Separation is the process of removing the bulk of the circulating water, foam and sludge from the steam and is comparable to the hand wringing of a bunch of wet clothes taken from a tub of dirty wash water. Steam washing is a process of rinsing a separated steam with fresh, and relatively clean, feedwater and is comparable to the rinsing of washed clothes in fresh water. Steam drying is the process of eliminating last traces of moisture from a separated or washed steam and is comparable to passing the clothes through a pressure wringer. Separation is always necessary, steam washing may be optional, and steam drying depends on the degree of purification desired. Steam for heating or plant process does not usually require the same degree of purification as steam that is to pass through a high-pressure superheater for use in a turbine.

All of the steps mentioned must be accomplished in the boiler drum space available above the normal water level. The proper allotment of available space to accomplish all three steps is a requisite of successful performance. In boilers having only one upper drum it is not always possible to accommodate all three steps unless the drum is extra large or the rating is very conservative. Since separation and drying are usually necessary, washing is often omitted in such boilers. In boilers having two or more upper drums, separation can be assigned to the more active front drums, and washing and drying combined in the upper rear drum. Fig. 1 shows the general process of separation and purification in a single drum boiler and Fig. 2 shows the sequence in a three-drum boiler having two upper drums.

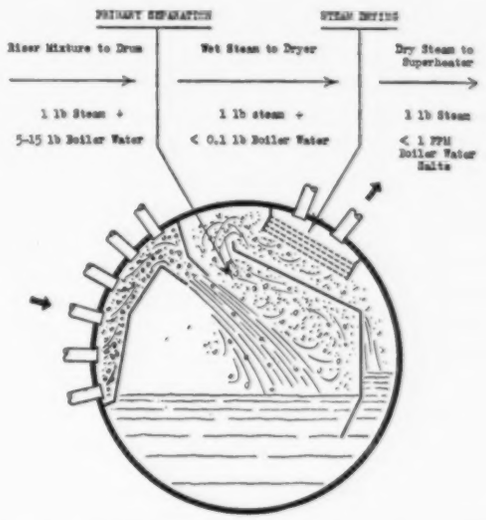


Fig. 1—Separation and purification in one drum

The primary separation and final drying steps involve the separation of water from steam, rather than the separation of steam from water. In primary separation, the object is to separate a relatively large weight of

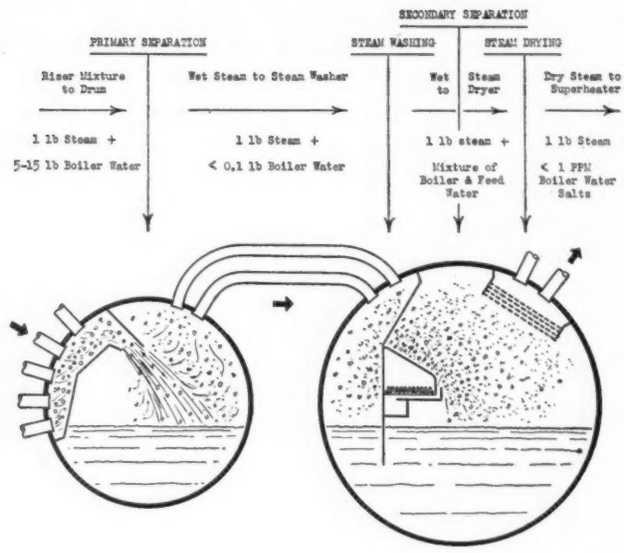


Fig. 2—Separation and purification in two drums

relatively heavy liquid from the steam. In drying, the object is to separate a small weight of liquid, usually dispersed as spray, from a relatively large mass of steam. Necessarily, the principles involved in the design of equipment for these two processes differ and it is important that satisfactory primary separation be obtained or the subsequent washing and drying will be subjected to a burden for which they are not designed.

It is desirable that the steam leaving a primary separator contain less than 5 per cent, and not more than 10 per cent, moisture. To reduce the 5 to 15 lb of circulating water, delivered to the separator with the steam, to less than 0.1 lb in the steam leaving the separator, separator efficiencies of 98 to 99 per cent are required. To reduce further the 0.1 lb of moisture in the steam from the separator, to a moisture content equivalent to a desired purity of less than 1 ppm contamination, additional dryer efficiencies of 98 to over 99 per cent are required. To obtain the desired steam purification in a single stage of separation would require efficiency of over 99.95 per cent, a perfection that would be difficult to attain.

Figs. 3, 4 and 6, which are based on simple calculations, make it obvious why high purity of steam cannot be obtained in a single-step process and why failure of primary separation imposes a serious burden on subsequent washing and drying. In Fig. 3, with a boiler-water concentration of 1500 ppm and a circulating ratio of 10 lb of water per pound of steam, the contamination to be removed from the steam is in the order of 15,000 ppm. Even a primary separation efficiency of 99 per cent reduces this contamination only to 150 ppm, and if primary separation efficiency drops to 85 per cent, the contamination in the separator outlet steam is over 2000 ppm.

Fig. 4 is based on similar calculations in terms of moisture in the steam rather than equivalent ppm of impurity. With a circulation ratio of 10 lb of water per pound of steam, the per cent, by weight, of liquid in the mixture to be separated is 91 per cent and a separation efficiency of 99 per cent is required to reduce this moisture content to less than 10 per cent. Drop in primary separation efficiency to 95 per cent leaves over 30 per cent moisture in the separator outlet steam. It is evident that any such contamination as 2000 ppm or 30 per cent moisture, in the steam delivered to a steam washer or steam dryer, imposes a serious burden on their performance.

In Fig 5, with boiler-water concentration of 1500 ppm and with 10 per cent moisture in the steam to a dryer, a separation efficiency of over 99.5 per cent is required in the dryer to reduce the outlet steam impurity to less than one ppm. Drop in this efficiency to only 98 per cent, results in over three ppm in the outlet steam.

Although the densities of steam and water approach each other as operating pressure increases, as shown in the change in density ratio in Fig. 6, the water is more than seven times heavier than the steam at 2000 psi, more than ten times heavier at 1500 psi and more than twenty times heavier at pressures of 1000 psi or less. Thus, if primary separation involved only the removal of mass liquid from the steam, these differential densities would be ample to give satisfactory results with relatively simple methods and a variety of equipment design. The problem is complicated, however, by the fact that the liquid to be separated is seldom entirely in the form of bulk liquid. Variable proportions of it are usually present as atomized spray and in the form of foam bubble films. Equipment cannot be designed to give equal efficiency of separation for all three of these forms of liquid and when the proportion of spray and foam becomes excessive, the primary separation efficiency tends to fall off and the burden on the subsequent steps of washing and drying becomes excessive. The reason for the difference in performance of similar drum internals in different boilers can usually be traced to difference in the proportion and distribution of these three liquid phases of the water to be separated.

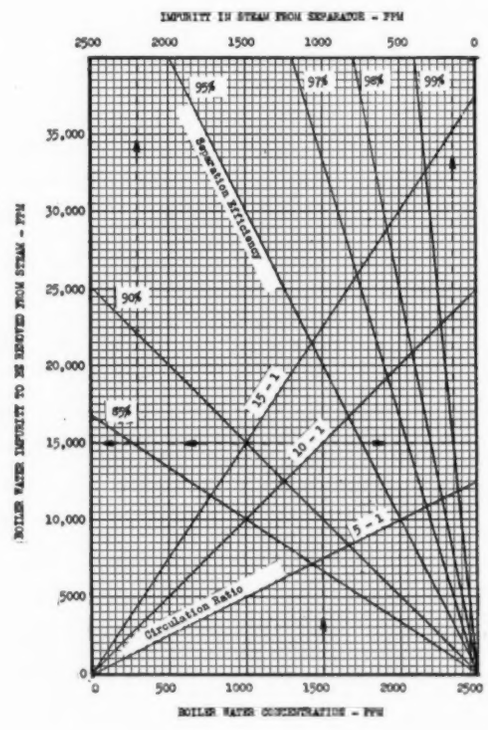


Fig. 3—Relation between boiler-water concentration, impurity in steam and removal of impurity

When a separator is not able to control a foaming or excessive spray condition, it is sometimes possible to effect improvement by a change in design or arrangement of the internals. There are limits, however, to the control obtainable by such mechanical methods and in some cases it is necessary to reduce operating conditions of capacity and boiler water concentration or obtain control of a foaming condition by a change in feed and boiler water conditioning.

In one design of separator the riser mixture is so directed across the steam outlet of the primary separator that it forms a dynamic, hydraulic barrier through which the steam may pass but by which foam is repelled and broken up.

The steam leaving a primary separator is delivered to a steam washer or directly to a steam dryer. Such steam should contain a minimum of residual boiler water to avoid contamination of the washing process or overload on the dryer.

Steam washing is obviously a process of mixing steam with water rather than a process of separation. The problem in washing is to obtain a maximum of contact between the steam to be washed and the wash water, in a minimum of time, and to obtain uniform distribution of steam and water flow through the washing equipment.

There are three phases to the steam washing process, all of which contribute to purification of the steam. First, there is the substitution and dilution of dirty boiler water by clean feedwater. Second, there is simple mechanical elimination of boiler water by contact with the washer in the same manner as separation is effected by a plate baffle. Third, there is condensation in the washer, which is inherently a deaerating feedwater heater. In mixing steam with cooler feedwater, a part of the steam is condensed to heat the water to saturation temperature. Small particles of dirty moisture in the incoming steam serve as nuclei on which this condensation takes place and the resulting increased weight of the moisture particles promotes their easy separation from the steam.

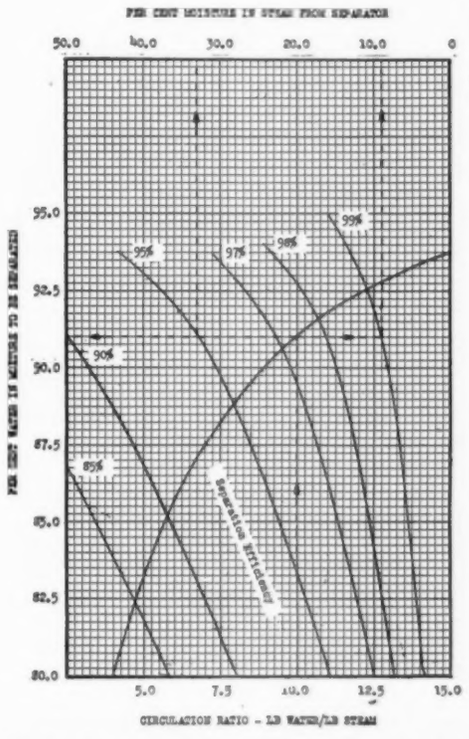


Fig. 4—Water in mixture to be removed with different circulation ratios and per cent moisture in steam

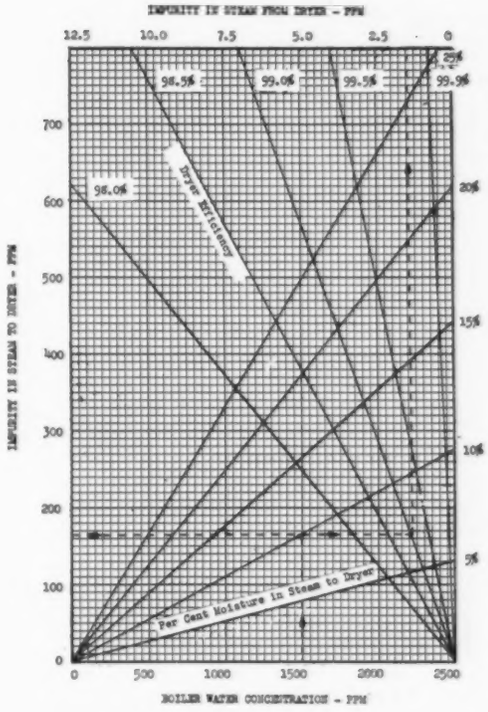


Fig. 5—Relation between boiler-water concentrations and impurity in steam to and from dryer

The performance of a steam washer depends on the following factors:

1. Solids concentration in the feedwater.
2. Solids concentration in the boiler water.
3. Quality of the separated steam entering the washer.
4. Quality of the washed steam leaving the washer.
5. Amount of purely mechanical separation that occurs in the washer.

Reliable data on washer performance are difficult to obtain, but for the same inlet and outlet steam quality, there is little doubt that a washed steam is cleaner than an unwashed steam.

The steam from a separator or washer is finally passed through a dryer to remove the last traces of moisture and dirt. Steam drying is a misnomer in that no evaporation is involved. In the design of an efficient dryer, the amount of contact surface, steam velocity, irregularity of the steam passages, and time of contact are important. The object in drying is to bring all of the steam in contact with the dryer surfaces during its passage through the dryer in order that the suspended moisture may be deposited.

As pointed out above, the process of drying is a process of separating relatively small amounts of suspended moisture from the steam and is essentially a filtration process. Dryer design, however, cannot more than approach that of a true filter because of such practical limitations as pressure drop, drainage, plugging with dirt, and corrosion.

The separating efficiency of a dryer should be such that the outlet steam will be of practically constant purity over the operating range, up to the point of overloading. A dryer becomes overloaded when the rate of separation in it exceeds the rate at which the dryer permits gravity drainage of the separated moisture. Steam velocity through a dryer must be limited, the limitation varying somewhat with operating pressure. At low pressures, the average velocity may be as high as 8 to 10 ft per sec but at high pressure this velocity may have to be rreuced to less than 2 ft per sec.

An important factor in dryer performance is the amount of residual moisture in the steam delivered to the dryer. Excessive moisture in the steam to the dryer may overload the dryer drainage capacity and cause temporary or local carryover, especially during changes in rating.

Various arrangements of screens and closely spaced plates are the usual design of dryer. A drop in dryer

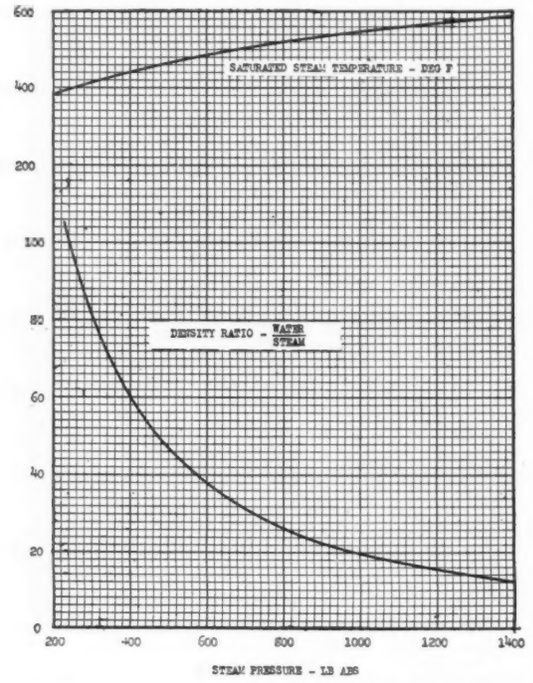


Fig. 6—Water-to-steam density ratios with varying pressure

separation efficiency, because of leakage, from 99.5 to 98.0 per cent makes a difference between satisfactory and unsatisfactory outlet steam purity.

No discussion on steam separation and purification would be complete without a word about dry drums. A dry drum is one located above the water level, in which no water level is maintained, and through which the steam passes on its way to the superheater. Moisture, separated in such a drum, is discharged externally through traps or drained back into the boiler system.

The effectiveness of a dry drum depends on the type of carryover to be handled in such a drum. In cases of priming where bulk liquid is carried up to the drum as a result of high water levels or surging, an open dry drum is effective in preventing heavy carryover to the superheater, but when the carryover to a dry drum is largely foam and spray that escapes through the regular drum internals, a dry drum is of little use unless it is equipped with suitable internals.

The unseparated moisture and its associated solids left in the steam after passing through the separation and purification equipment is called carryover. There are various degrees of carryover, ranging from a normal impurity of less than 1 ppm to moisture contents that reduce superheat to saturation temperature and require immediate correction. Carryover, which is within guaranteed limits or which requires only minor improvement to be satisfactory, is termed normal carryover. Carryover, which is excessive and which requires immediate or radical improvement, is termed abnormal carryover.

With the exception of priming, which is mechanical carryover of excessive amounts of water at high water levels or under surging conditions, practically all carryover is traceable to the minor portion of the boiler water in the form of spray or foam. In most cases, normal carryover is traceable to small amounts of atomized mist that escapes through the steam dryer, and abnormal carryover is due to foaming of the boiler water. In some cases, abnormal carryover due to spray can be caused by leaky drum internals or high ratings, but such carryover is easily corrected by proper design and installation of the drum internals.

Thus, the majority of carryover problems boil down to control of foaming in the boiler. Foaming develops when the water films around the steam, as it is generated at the heating surfaces, and becomes stabilized by substances in the boiler water. These foam films do not break readily and are carried up to the boiler drum where they accumulate and eventually fill the drum to give carryover. At low ratings and with large diameter drums, sufficient time is allowed for destruction of the foam films and liberation of the entrapped steam and foam carryover may not become a problem, even with high boiler water concentrations and with considerable foam generated in the boiler. At higher ratings and with smaller drums, the rate of foam generation tends to exceed the rate at which the foam films can be destroyed and boiler water concentration limits are usually lower.

At higher pressures, the generated steam and foam bubbles are smaller and more difficult to destroy. The following tabulation lists boiler-water concentration limits set by the American Boiler Manufacturers' Association. These limits are average values, based on experience, above which manufacturers do not care to guarantee steam purity. It is important to note that these values are entirely arbitrary and it should not be inferred that above these limits, foaming will develop and below them foaming will not develop.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION
BOILER-WATER STANDARDS

Pressure, Psi	Boiler-Water Concentration, Ppm	
0– 300	Not over 3500	Alkalinity not to exceed 20 per cent
301– 450	Not over 3000	of total concentration
451– 600	Not over 2500	Total soluble solids plus suspended
601– 750	Not over 2000	solids not to exceed soluble solids
751– 900	Not over 1500	by over 5 per cent
		Oil or grease that can be extracted
901–1000	Not over 1250	by sulphuric ether or chloroform
1001–1500	Not over 1000	not to exceed 7 ppm

Foaming is inherently a chemical and physical characteristic of the boiler water and with a foamy water, foam formation is necessarily a result of steam generation. The control and destruction of this foam is an extra burden on the separation and purification equipment, added to their basic function of separating boiler water from steam.

Fuel Burning on the Continent

The following is abstracted from a paper by Dr. J. H. Bock on "Boiler Installations on the Continent, and Future Problems" as prepared for presentation before The Institution of Mechanical Engineers (London). It deals with types of fuel-burning equipment designed for the diverse fuels available on the Continent. A second part of the paper, not here abstracted, covers boiler designs and a possible line of future development involving low-pressure mine-mouth stations for burning inferior fuels and high-pressure power stations in conjunction with district heating in towns and cities.

THERE are three main deposits of coal in Europe. The first, originating in England and Scotland, descends under the North Sea and comes up again in Northern France, parts of Belgium and Holland, as well as in the Ruhr and Saar Basin. The second largest deposit is found in Polish Silesia and in the adjacent countries, Czechoslovakia and Germany. The third deposit is inside the Donetz Basin in Russia. All three have coal of similar qualities varying from anthracite to the bituminous type. A few coal fields of minor importance, are to be found in Jugoslovia, Hungary, Germany and Rumania.

Due to the scarcity of fuel, and also to the difficulties of mining some of the coals, large quantities of duff, middles and slurry have to be burned on the Continent. These are used mostly at the pits for steam raising in power stations or factories near the coal mines.

The next type of fuel of importance on the Continent is lignite, which is found in large quantities in Central Europe and Russia, though the largest deposits are in Germany and Czechoslovakia—the latter having lignites and brown coals of very high quality. Lignite deposits of less importance are found in Hungary, Rumania and Jugoslavia.

Peat is found in Ireland, Scotland, England, North Germany and Poland, though the largest deposits are in Russia, where it represents an important factor in the generation of power. Also, much wood is burned in the smaller boiler plants and, in some cases, in large installations where large quantities are available.

Fig. 1—Sketch of traveling-grate stoker with pendulum firebridge

Combustion appliances in England are mostly designed for a certain kind of fuel. However, on the Continent the designer is often asked for furnace designs which can be used not only with different qualities of the same fuel, but also with different fuels such as lignite and coal, sometimes simultaneously.

Traveling-Grate Stokers

Fixed grates are employed for burning relatively small quantities of fuel. The traveling-grate stoker was introduced on the Continent at the beginning of this century originally as the chain-grate type, but it was soon found unsuitable for coals having a high ash content, as the chain links were adversely affected. This led to adoption of the type having the grate bars carried by separate carrier bars mounted on the running chains. This type, which came into use on the Continent about 1910, has entirely replaced the chain-grate stoker. Grates up to 27 ft wide were used, although the present practice is not to ex-

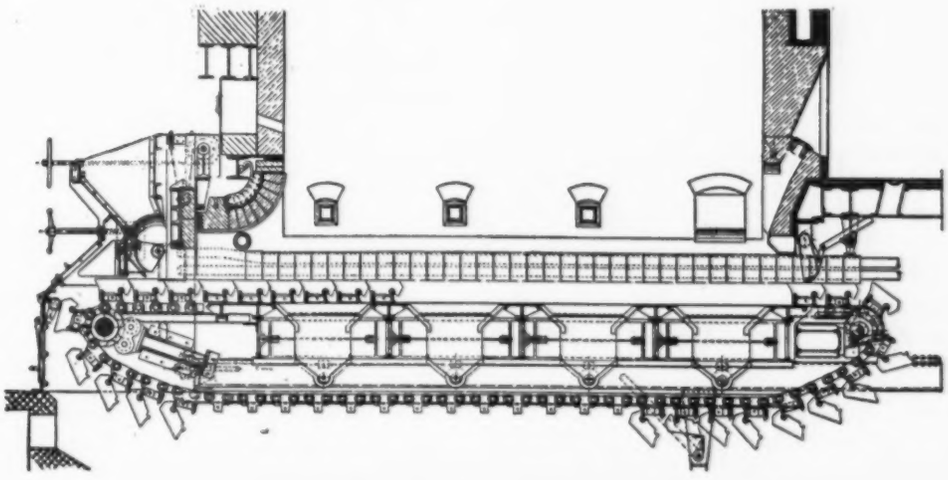


Fig. 2—Much used modern traveling-grate stoker

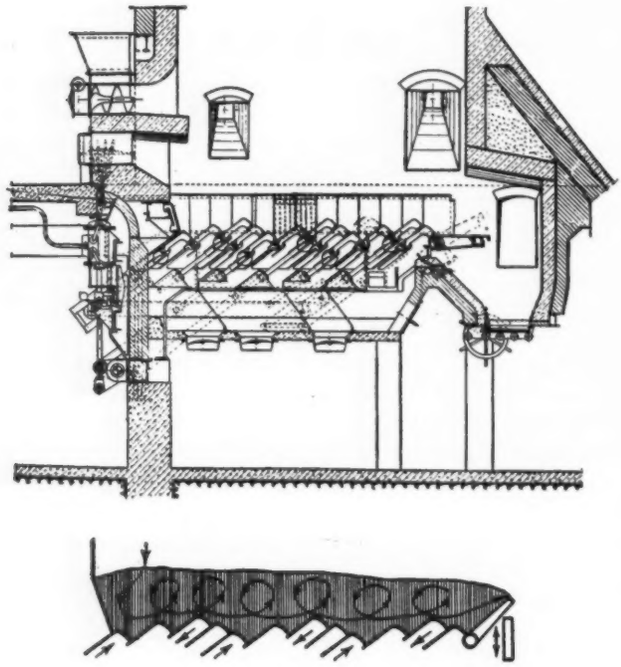


Fig. 3—Sectional view of "cascade grate"

ceed 15 or 16 ft. Where greater width is required two stokers are generally employed side by side.

One form of this type of grate widely used on the Continent is the so-called "pendulum firebridge" fitted at the back end of the grate, and which has replaced dumping bars or dumping gear. This, as indicated in the sketch, Fig. 1, consists of several pendulums of cast iron representing little grates either bare or lined with firebrick and swinging on bearings that are fixed into an air- or water-cooled hollow beam. Each pendulum is held in a nearly vertical position by an adjustable counterweight. As soon as the pressure of the clinker is greater than the lever action of the counterweight, the pendulum swings out and releases the slag or clinker. Most of these pendulums are built as grates, and the passing air not only cools the pendulums but also burns the remaining combustible in the ash. A modern traveling-grate stoker of this type is illustrated in Fig. 2.

Generally, the traveling-grate stoker with properly designed accessories can burn, with a good efficiency, at a high rate any coal having more than 6 per cent volatile, an ash content up to 25 per cent with CO_2 of 15 to $15^1/_2$ per cent. The only difficulties met with are those encountered with coals above $1^1/_2$ in. size and badly screened with a large proportion of fines. This is due to the thickness of the fuel bed (normally between 4 and 6 in. and in exceptional cases 8 in.) and to the forced draft which, with a thin fire, causes fly ash.

Underfeed Stokers

Most of the small underfeed stokers found on the Continent are similar to those used in the United Kingdom. The larger stokers of the multiple-retort type are of American design built under license by several firms. Since 1930, however, they appear to have lost favor, compared with the modern traveling-grate type and the use of pulverized coal, probably because they are suitable for a limited range of fuels.

Stokers for Low Grade Coals

Two major designs of stoker are in use for burning high-ash, high-moisture coals of low calorific value and often low ash-fusion points, including slurry, middlings, pit refuse, treated fines, etc. Their main features are a thick fuel bed, the rotation of the fuel on the grate (to break up clinker) and the introduction of heated air, if available, as well as secondary air.

The first of these is known as the "cascade grate" as shown in Fig. 3. This consists of fixed and movable steps carrying the grate bars. The actual working of the grate is based on the alternating movement of two steps separated by a fixed step. A screw conveyor is used to supply the fuel which is introduced at the front arch and falls by gravity onto the front part of the stoker.

The second design for burning these poor quality fuels is the "push-back," or Martin, grate. Here again, steps carrying the grate bars move backward and forward alternatively. The fuel travels twice the length of the grate as shown in Fig. 4. The larger slag and clinker particles gather on the swinging clinker grate and are discharged into the ashpit where a clinker crusher breaks them into smaller sizes for easy disposal.

Both these types are employed extensively at coal mines and factories because of their capacity for dealing with fuels of widely varying characteristics. Their rating is as high as 600,000 to 700,000 Btu per sq ft of grate per hour, and they will handle up to as much as 80 lb of middlings per square foot of grate per hour. They can be built up to 20 ft in width and can fire steam-generating units of 200,000 lb per hr output.

Burning Lignite or Brown Coal and Peat

Czechoslovakia, having the best quality lignite, was the first to burn it on a large scale, and the common fixed-step grate, on which it was originally burned, was adapted to operate as a mechanical stoker as early as 1908. The principal feature is the movement of the steps backward and forward horizontally, pushing the fuel gradually from

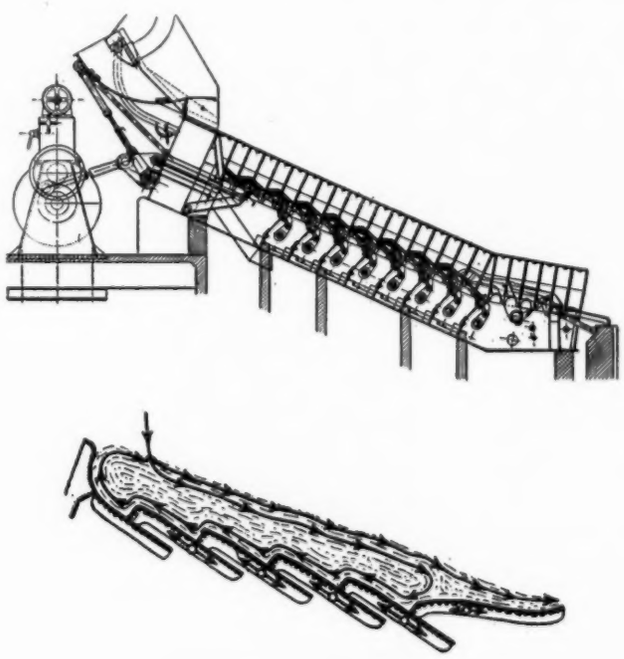


Fig. 4—Views of Martin grate

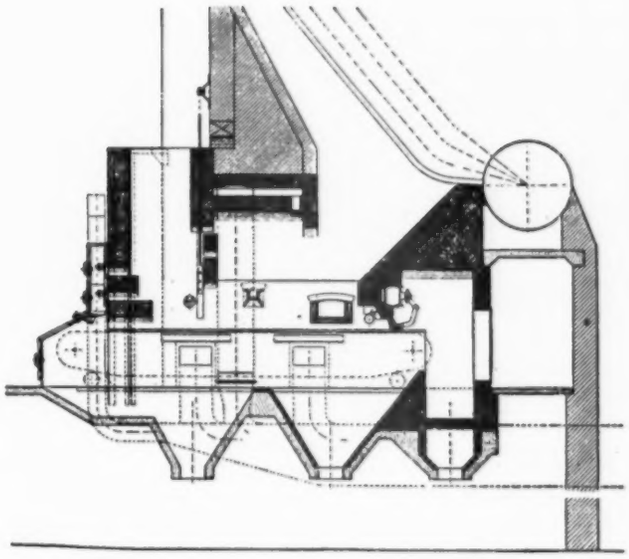


Fig. 5—Traveling-grate setting for burning peat

the top toward the slag grate at the rear. The fuel bed is fairly thick, approximately 15 to 20 in. at the guillotine. The firing rate is less than that of the traveling-grate stoker and usually is not more than 300,000 to 400,000 Btu per sq ft per hr. Since most of the brown coals and lignites have very low calorific values, due to high moisture content, only part of the grate surface is allowed to radiate heat to the boiler surface, the other part being prevented from doing so by suitable firebrick baffles. These grates are also used with forced draft, but only with low pressures of 1 to 2 in. wg.

The largest deposits of peat on the Continent are in Russia, and the modern method of burning dry peat on a traveling-grate stoker was invented by Professor Makarieff. The arrangement, shown in Fig. 5, employs a vertical shaft over the front of the grate, through which the peat is fed. Upon entering the furnace it is dried partly by the hot brickwork and partly by hot air entering the pit through suitable channels. The rate of combustion is high—as much as 700,000 to 900,000 Btu per sq ft of grate per hour, and peat containing up to 60 per cent moisture can be burned. From 15 to 16 per cent CO_2 can be obtained and, as the ash content is very low, efficiencies between 85 and 90 per cent (based on the lower calorific value) can be reached. Some large power stations in Russia, as well as two in Germany and a smaller one in Czechoslovakia have been equipped with this type of grate.

Pulverized Coal

American development in pulverized coal firing has largely influenced Continental practice. To understand later developments in this type of firing it is necessary to consider the different characteristics of the Continental fuels with regard to their grinding qualities, as well as their burning qualities. Brown coals and lignite have a high moisture content, but are also high in volatile and need not be ground so finely. Lignite, which has very low calorific value, requires a considerable amount of power, due to its high moisture content. In some cases where the moisture content is exceedingly high, a central system of special dryers is employed in which the fuel is dried before being pulverized.

Mill Combustion

In Germany "mill combustion" came into being for the burning of lignite and brown coal of high moisture content, based perhaps on experience in the burning of milled peat in Russia. The "mill combustion" system is shown in Fig. 6 and consists mainly of three parts—the feeding and screening shaft with an impact rotor at the bottom; the combustion chamber proper; and the ashpit with the grate below the combustion chamber. The fuel enters the feeding shaft and drops by its own weight into the impact rotor where it moves around until the size is so small that, through the fan effect of the rotor, it is carried into the combustion chamber. The fuel is dried either by hot air or hot flue gases, or a mixture of both, not only in the rotor chamber but also on the way to the combustion chamber.

When the fuel enters the combustion chamber it ignites, the fine particles burning out on their way through the chamber before entering the first row of boiler tubes, the larger ones descending on to the ashpit which is designed as a grate. Here they remain until completely burned out. Grinding has to be carried only sufficiently far to prevent the unburned particles of fuel from entering the boiler and causing the fly ash to contain a large amount of carbon. A movable plate is fixed a certain distance above the rotor, which determines the degree of fineness. The grinding is very rough and, due to this fact as well as to the omission of the fuel pipe, burner and classifier, the power consumption is only about 20 to 30 per cent of that with a normal impact mill.

Lignite containing up to 55 per cent moisture can be readily burned in this way, and certain bituminous coals have been burned successfully.

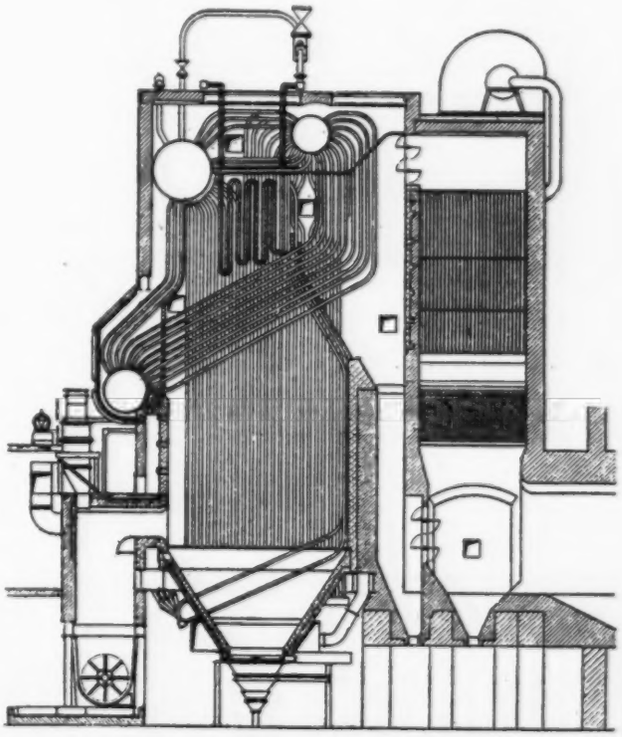
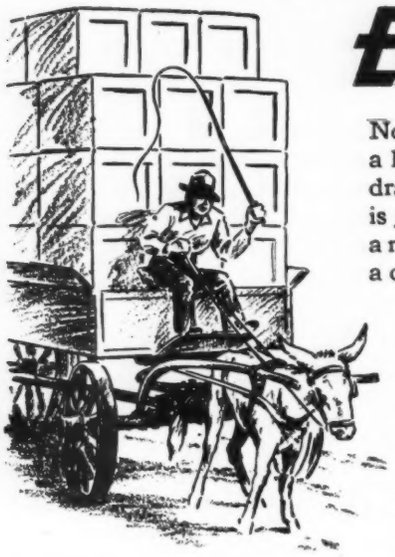


Fig. 6—Boiler with mill firing

To get *more* for your valve dollar *consult* POWELL *Engineering*



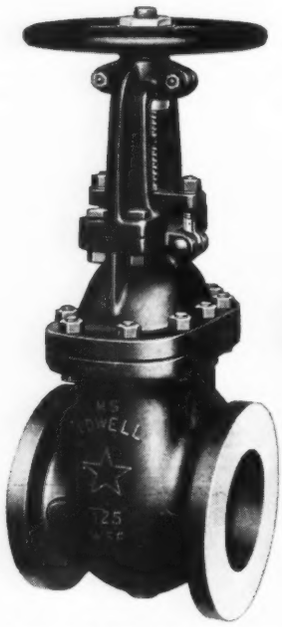
No one would expect a burro to pull a load that requires a heavyweight draft horse. But a sure-footed burro is just right for carrying a pack on a mountain trail where the power of a draft horse would be wasted.

And yet when it comes to valves, such "misapplication" is often encountered. *Many cases of failure are directly due to expecting service from a valve which it was not designed to give.* Consequent replacements are costly. On the other hand, it is not sound economy to use a valve of more expensive construction than the particular service requires. The Powell Line* of Bronze, Iron, Cast Steel and Corrosion Resistant Valves, is so *complete* that there's a POWELL Valve that's *just right* for every flow control condition encountered in modern industry. When you need valves for new installations or for replacements, don't risk "misapplication". Consult POWELL Engineering and *get more for your valve dollar.*

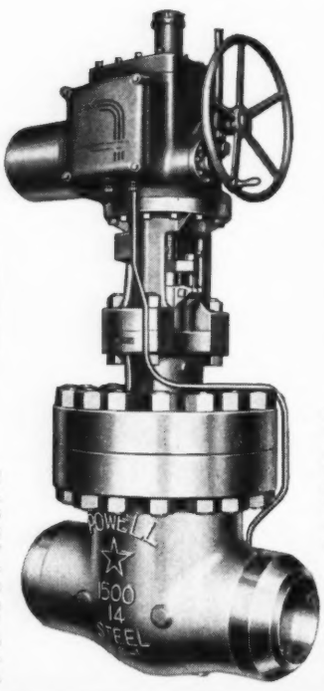
The Wm. Powell Company, Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

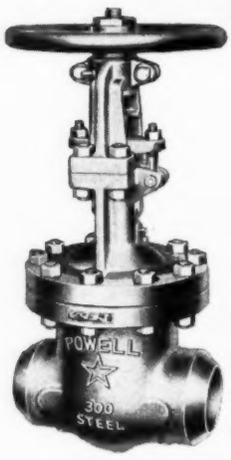
*In writing for catalogs kindly specify the service conditions under which the valves, in which you are interested, must operate.



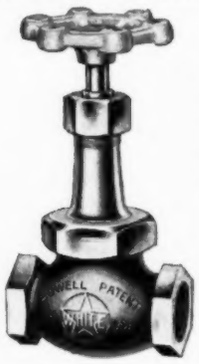
Large Iron Body Bronze Mounted Gate Valve for 125 pounds W. S. P. Made in sizes 2" to 30", incl. Has flanged ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Taper wedge double discs can be provided in sizes 2" to 12", incl. Seat rings and stem are bronze. Disc is bronze in 3½" and smaller size valves and bronze faced in the larger sizes. Also available in All Iron for certain services.



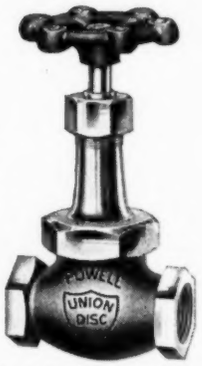
Class 1500-pound Cast Steel Gate Valve with welding ends, bolted flanged yoke, outside screw rising stem and taper wedge solid disc. Equipped with top-mounted electric motor operator for quick, positive opening and closing by remote control.



Class 300-pound Cast Steel Gate Valve. Has welding ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Powell Cast Steel Valves of all types are available in pressure classes from 150 to 2500 pounds, inclusive.



Small Bronze Globe Valve for 200 pounds W. S. P. Made in sizes ¼" to 3", incl. Has screwed ends, union bonnet, renewable, specially heat-treated stainless steel seat and regrindable, renewable, wear - resisting "Powellium" nickel-bronze disc. A long-life valve, designed to stand up under severe service conditions.



Small Bronze Globe Valve for 150 pounds W. S. P. Made in sizes ⅛" to 3", incl. Has screwed ends, union bonnet. Regularly furnished with renewable vulcanized composition disc for steam service but special discs are available for other services.

POWELL VALVES

New Standard for Mineral Wool Insulation

The latest development in the joint standardization program of the National Bureau of Standards and the Industrial Mineral Wool Institute is the release of Commercial Standard, CS-131-46, on testing and reporting of all forms of mineral wool insulation, widely used by both steam power plants and manufacturers of electrical heating and refrigeration equipment.

Adhesive strength, corrosion resistance, coverage and temperature resistance, in addition to the basic feature of thermal conductivity, are among tested characteristics of importance to the power industry.

The forms of industrial mineral wool for which test methods are given are blanket, block, board, felt, granulated, industrial batt, insulating cement, loose, and pipe insulation of both blanket and molded forms.

Uniform and detailed methods of testing and recording physical and chemical properties are given. The forms of industrial mineral wool are defined and formulas given for fixing the conclusive factor of each test so that standards may be made available for the judgment of characteristics and behavior by uniform tests of any type of industrial mineral wool.

The test for adhesive strength of insulating cement is based on the power required to separate two metal elements of prescribed size which have been bound together with a layer of insulating cement. The formula gives a result in pounds per square inch.

The test for compressive strength applies to block, board, and insulating cement, and as in the preceding test, gives a result in pounds per square inch of compressive strength.

Corrosion resistance is tested for all types of industrial mineral wool except insulating cement. It is based on the relative effect on identical steel plates—one freely exposed to humidity, and the other protected between specimens of mineral wool material.

The coverage test applies to insulating cement only. The formulas express wet and dry coverage in square feet one inch thick per 100 lb of cement, volume change upon drying and dry density.

Density and thickness tests are established for industrial batt, blanket, felt and blanket-type insulation. By different methods, the same tests are made for block and board insulation and for molded pipe insulation.

The fire-resistance test is made with a large Bunsen-type burner on all mineral wool products in order to classify the materials as (1) incombustible, (2) fire-retardant, (3) slow-burning or (4) combustible.

Moisture adsorption tests are described for all mineral wool products except insulating cement (which is applied wet to equipment operated at relatively high temperatures), the results showing as percentage of adsorption by weight and by volume.

A test for odor is included for the benefit of users in the low-temperature field. Tests of this character call for the average opinion of at least three observers using the effect on butter as a sensitive control.

Tests for shot content (non-fibrous content) are specified for industrial batt, blanket, felt, granulated, loose and blanket-type pipe insulation. The formula for determination of the factor expresses shot content as a percentage of weight.

Temperature resistance tests for all mineral wool products are specified. These determine the behavior of the material during, and the appearance after, protracted exposure to any specified temperatures.

Four procedures are given for determining the all-important factor of thermal conductivity. Three alternate methods for blanket-type and molded-pipe insulation, and one test for all other industrial mineral wool products, are described. For pipe insulation there is the choice between methods using guarded ends, calculated end losses, and calibrated end losses, and for other materials the method of the guarded hot plate. The formula in each case gives the thermal conductivity (in Btu per hour per square foot per degree Fahrenheit and per inch thickness) for the mean temperature of the test.

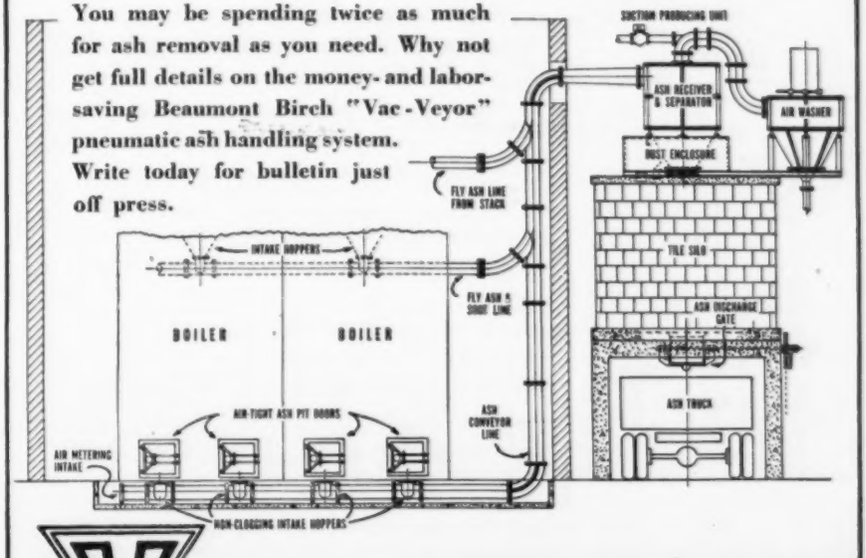
Several of the tests established are based on methods adopted as standard by the American Society for Testing Materials. Others have been worked out by the Specifications Committee of the Industrial Mineral Wool Institute.

Pipe and Bolting for High-Temperature Service

The sudden failure of a carbon-molybdenum grade of pipe in a high-temperature high-pressure installation about two years ago caused a flurry of excitement, with much ensuing study and research to determine the causes. The problem was particularly pressing since there were many other installations of this particular grade of material which affords the necessary resistance to creep at elevated temperatures. The failure occurred in the weld-affected zone and was attributed to so-called graphitization or the formation of chain-like graphite nodules. Whether the use of aluminum in killing of the steel contributed to graphitization has been discussed in many technical papers since then, but the A.S.T.M. Committee's Subcommittee on Materials for High-Temperature Service was essentially concerned in developing or standardizing on a material which would inhibit graphitization. Since the incorporation of about 40 to 60 points of chromium seemed to provide the best safeguard, the new Specifications for Carbon-Molybdenum Steels (A 280–46 T) were agreed on after considerable discus-

HOW MUCH ARE YOU PAYING TO HANDLE ASHES?

You may be spending twice as much for ash removal as you need. Why not get full details on the money- and labor-saving Beaumont Birch "Vac-Veyor" pneumatic ash handling system. Write today for bulletin just off press.



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sion. Apparently no evidence exists to show that this material has graphitized below say 925 F, but only time and widespread usage will prove the worth of the material.

Meanwhile the studies continue of other possible steels which might be used, including some with higher chromium content, 1 per cent or over.

The revised Specifications for Alloy-Steel Bolting Materials for High-Temperature Service (A 193–45 T) now embody three grades formerly covered in the widely used Standard Specifications A 96 which do not give detailed chemical requirements, and with the approval of the revised tentative, the former Standard A 96 was withdrawn.

Power Show This Year

After a lapse of several years during the war, when the Grand Central Palace, New York, was being used by the Army, plans are now going forward for the 17th National Exposition of Power and Mechanical Engineering to be held there the week of December 2 to 7, concurrently with the Annual Meeting of the A.S.M.E. It will be under the same management as in former years and will have essentially the same Advisory Committee of which I. E. Moultrop has long been chairman. As the first post-war exposition in its particular field and in view of the present activity in power plant work, this year's show is expected to be unusually large, both in the number of exhibits and in attendance.

Appointed Export Manager

Theodore A. Dyke has been appointed manager of the Export Division of Combustion Engineering Company, Inc., New York, succeeding the late J. B. Crane.

Mr. Dyke, with a background of chemical engineering and business administration, joined Combustion Engineering Company in 1936. For more than a year during the war his services were loaned to the U. S. Government as Chief of the Industrial Equipment Group in the Requirements Division, Office of Lend-lease Administration, under Mr. Stettinius. Over the past ten years he has been closely identified with the numerous foreign contracts of his company, particularly those pertaining to Latin American countries in which he has traveled extensively. He is a member of the American Society of Mechanical Engineers and is active in the Export Managers Club.

Coal Stocks Low

Reflecting the curtailed receipts and enforced conservation of bituminous coal supplies in May, coal consumption by electric utility power plants dropped to 4,937,-179 tons during the month, the Federal Power Commission reported, as of July 1. The Commission also reported that the coal stocks of electric utility power plants, as of June 1, 1946, were 15.8 per cent less than stocks on May 1 and that total stocks were at their lowest level since the summer of 1941, despite widespread conservation measures.

Stocks of coal on hand at electric utility power plants on June 1 totaled 11,443,348 tons, equivalent to 72 days' supply at the April rate of consumption. This compares with 75 days' supply on hand the first of the previous month.

Of the total coal consumed in May, 4,585,104 tons were bituminous, a decrease of 11.7 per cent below April 1946 consumption, and 352,075 tons were anthracite which was an increase of 24.7 per cent when compared with the preceding month.

Fuel oil consumed in May totaled 3,512,513 barrels compared with 2,156,552 barrels in April, an increase of 62.9 per cent. This established a record monthly use of fuel oil for generation as power plants normally burning coal turned to the relatively more available oil.

Gas consumption in May increased 14.0 per cent compared with the amount of gas consumed in April. In May, 26,639,480 MCF of gas were consumed compared with 23,358,952 MCF during the previous month.

New Officers of A.I.E.E.

At the Annual Meeting of the American Institute of Electrical Engineers in Detroit on June 20, the following new officers were elected for the year beginning August l, 1946: President, J. Elmer Housley, District Power Manager of the Aluminum Company of America; Vice Presidents, E. W. Davis, O. E. Buckley, T. G. LeClair, R. F. Danner and C. F. Terrell; Directors, J. F. Fairman, R. T. Henry and E. P. Yerkes; Treasurer, W. I. Slichter. These, together with the hold-over officers, will constitute the Board of Directors for the next administrative year. The annual report of the Board showed a total membership, as of April 30, 1946, of 25,090.

Obituary

Walter J. Consler, for the last five years general superintendent of the electrical department of the Rochester Gas & Electric Corporation was killed in an automobile accident on June 14. Starting with the Company as an errand boy in 1900, he had advanced through successive promotions to the responsible position held at the time of his death. He is succeeded by R. H. Macomber.

In his station overlooking stockpile, operator has "push-button" control of entire operation of scraper, including travel of tail tower seen in background.

Large Sauerman Crescent scraper bucket ranges across pile 400 ft. wide and reclaims coal to ground hopper at rate of about 5 tons a minute.

ONE MAN *handles*
ALL *your coal storage*
when you are equipped with

SAUERMAN
SCRAPER SYSTEM

ONLY ONE MAN with finger-tip control, stores and reclaims coal easier and faster, whether you store a few cars per day, or many. Makes cleaner, safer piles *at a BIG saving.* Costs only a few cents per ton handled!

Other advantages of Sauerman equipment: Maximum tonnage stored in all available space—stocks in compact layers—no air pockets for spontaneous combustion—low installation cost—simple and economical to maintain.

You might have DOUBLE the amount of coal stored for the present emergency, if you had the Sauerman Scraper System. Be prepared!

Send for complete Sauerman Catalog, and see how others have profited with this labor-saving, money saving equipment.

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Power Plants for China

Gilbert Associates, Inc., has announced the signing of a contract with the Chinese Supply Commission for the design, erection and operation of seven central electric generating stations to be installed in Shanghai and other cities and towns in China, as a part of a long-range program for the electrification of industry and homes in that country. Contracts for still other installations are expected to follow as a part of this program.

These plants will be equipped by American manufacturers, and assembled at a West Coast shipping point for installation in China as rapidly as possible.

Alaska Coal

Alaska, northernmost territory of the United States, has enough coal reserves to meet the immediate fuel requirements of its expanding industrial and commercial economy, according to a comprehensive report on analyses of Alaska coals released by the Bureau of Mines. Coal deposits totaling nearly 100 billion short tons, chiefly of lignite and subbituminous rank are said to underlie extensive areas.

Although coal is widely distributed through Alaska, most of the existing developments follow the main lines of transportation, with the principal sources at this time being the Healy River field, about 75 miles southwest of Fairbanks, and the lower Matanuska Valley field, about 40 miles northwest of Anchorage.

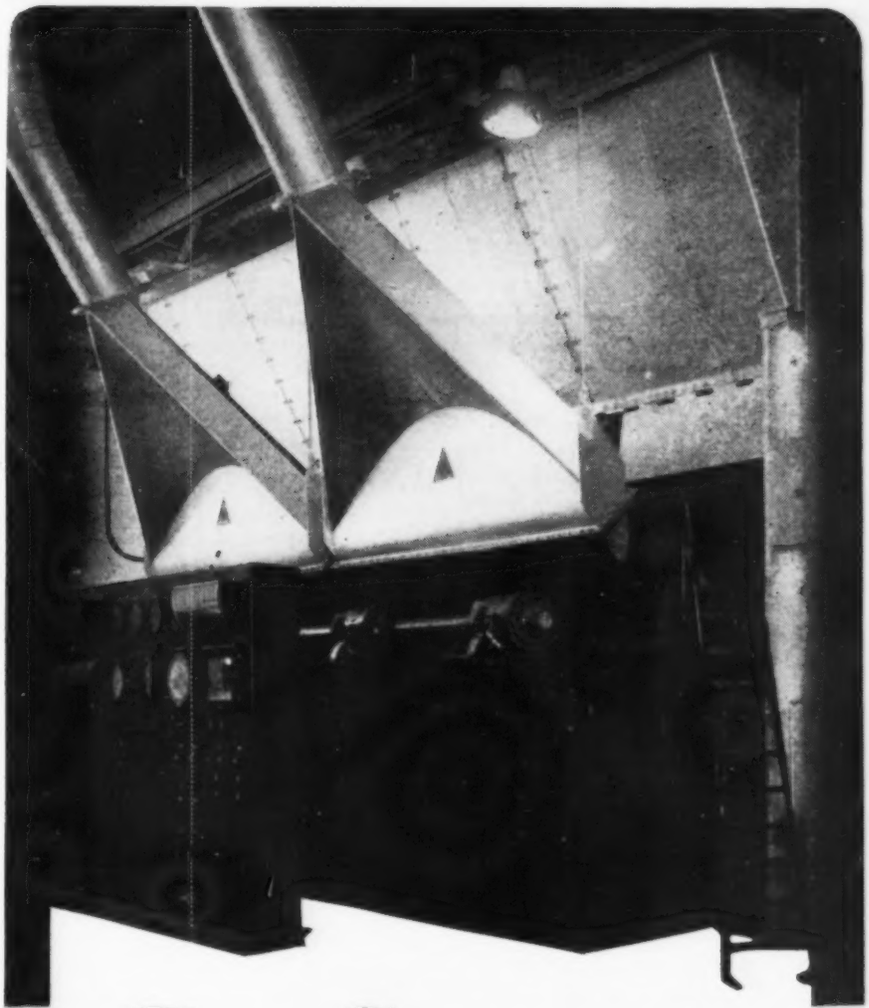
Noting that production of coal in Alaska amounted to less than 200,000 tons a year prior to World War II, the publication discloses that the output has increased by 50 per cent during recent years. Because of an expanding population and increased industrial activity, coal production will probably continue to rise during the postwar period.

Business Notes

The Crosby Steam Gage and Valve Company, Boston, and the Aston Valve Company of Cambridge, Mass., have been brought under joint management with William P. Husband, Jr., as president of both companies. The products manufactured by these companies are similar in their application, the former producing safety and relief valves, gages, etc., for the marine, petroleum and industrial fields, and the latter, such products for the railroad field. It is believed that substantial advantages will accrue to customers of both companies as a result of joint management, through elimination of duplication.

The Paul B. Huyette Company of Philadelphia and New York is celebrating its fiftieth year. Founded in 1896 by the late Paul B. Huyette as factory representative for several manufacturers, the organization has grown through the years until it now represents eleven manufacturers and, in addition, produces its own line of gages, valves, etc.

The Hagan Corporation, combustion and chemical engineers, Pittsburgh, has acquired the Willburt Company's Plant No. 1 at Orrville, Ohio, in which all Hagan equipment has been manufactured for the past 27 yr.



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Better fires on the stoker are an assured result if coal is fed to the stoker without segregation of coarse and fine pieces. S. E. Co. CONICAL Non-Segregating Coal Distributors are designed to deliver a uniform mixture to the stoker . . . consequently combustion is uniform, the greatest possible amount of power is extracted from the fuel and excessive maintenance of stoker arches and grates is eliminated.

Write for futher information on the CONICAL Distributor. Address Stock Engineering Co., 713 Hanna Bldg., Cleveland, Ohio.

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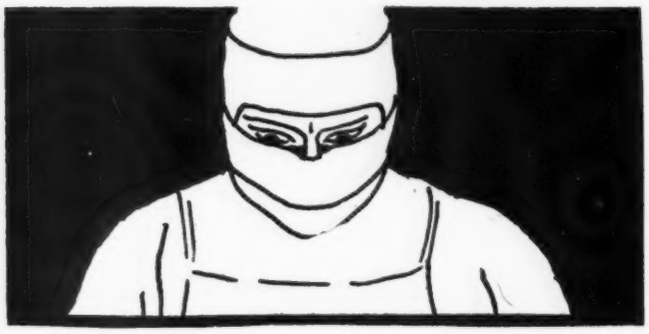

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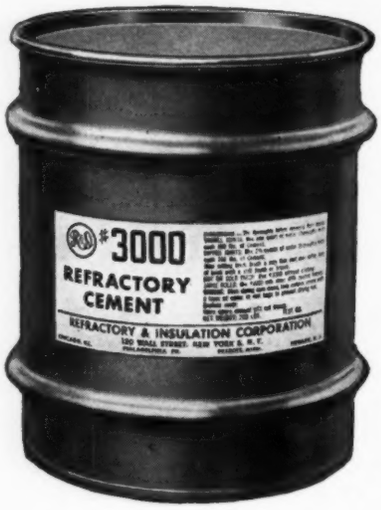
If firebrick mortality, like life mortality, were recorded statistically, you would use only R & I #3000 Refractory Cement—for it assures much longer life of firebrick settings.

R & I #3000 does not shrink, spall, bulge, crack, puff or fall out under the most severe firing. It protects brick from slag and abrasion.

Intermittent firing won't crack #3000, as it has the same expansion and contraction as #1 firebrick. It is also ideal for hot or cold patching.



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LIQUID Level Control

Your need for positive, accurate liquid level control on all important liquid vessels increases as you turn to higher pressures and faster steam generation. Swartwout now gives you a displacement type control incorporating instrument-like precision with simple rugged construction. The Swartwout L-1 Level Control has but two adjustments—no stuffing boxes, packing or grease seals. Write for full data which you find in Bulletin S-15.

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